MEDICAL LIBRARY

TRANSACTIONS

OF THE

AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS

VOLUME XV

TRANSACTIONS

OF THE

AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS

Thirty-fourth Annual Meeting held at
The Hotel Shoreham, Washington, D. C.

May 1 and 2, 1922

Vol. XV

UNIVERSITY OF MINNESOTA LIBRARY

Published for the Association by
Williams & Wilkins Company
Baltimore Maryland

OFFICERS OF THE ASSOCIATION FOR 1922

President

JAMES PEDERSEN, M.D., New York

Vice-President

WILLIAM E. LOWER, M.D., Cleveland

Secretary and Treasurer

RICHARD F. O'NEIL, M.D., Boston

Members of the Council

J. H. CUNNINGHAM, JR., M.D., Boston
ROBERT C. BRYAN, M.D., Richmond
THE PRESIDENT
THE VICE-PRESIDENT } Ex officio
THE SECRETARY

JUL 7 '47 U OF M BINDERY (B-M)

1168374

LIST OF MEMBERS

HONORARY MEMBERS

Dr. E. L. Keyes, Sr. (1886), 109 East 34th St., New York.
Dr. Edwin C. Burnett (1877), Century Building, St. Louis.
Dr. Abner Post (1887), 16 Newbury St., Boston.
Dr. Eugene Fuller (1893), 252 Lexington Ave., New York.

CORRESPONDING MEMBERS

Dr. E. Hurry Fenwick, F.R.C.S. (1906), 14 Saville Row, London, England.
Prof. Serg. Petr. Fedrov (1911), Petrograd, Russia.
Prof. Emile Jeanbrau (1911), 2 rue du Petit Saint Jean, Montpelier, France.
Mr. John Pardoe (1907), 77 Wimpole St., London, England.
Prof. Alfred Pousson (1907), 10 Cours Tournon, Bordeaux, France.
Prof. Cesar Roux (1911), Lausanne, Switzerland.
Prof. Th. Rovsing (1911), Copenhagen, Denmark.
Prof. Jean Rene Verhoegen (1911), Brussels, Belgium.
Mr. J. W. Thompson Walker, (1921) 30 Queen Anne St., London West, England.

FELLOWS

Dr. Gardner W. Allen (1893), 419 Boylston St., Boston.
Dr. W. T. Belfield (1888), 32 North State St., Chicago.
Dr. George E. Brewer (1890), 61 West 48th St., New York.
Dr. N. B. Carson (1892), Humboldt Building, St. Louis.
Dr. C. L. Gibson (1901), 72 East 54th St., New York.
Dr. W. F. Glen (1889), Independent Life Building, Nashville.
Dr. Robert H. Greene (1897), 78 East 56th St., New York.
Dr. H. McC. Johnson, (1896), 801 Central Trust Building, San Antonio, Texas.
Dr. E. E. King (1888), 61 Queen St., Toronto, Ont., Canada.
Dr. Bransford Lewis (1892), Century Building, St. Louis.
Dr. Edwin Martin (1892), 135 S. 18th St., Philadelphia.
Dr. Harvey G. Mudd (1880), Humboldt Building, St. Louis.
Dr. E. W. Ruggles (1905), 348 University Ave., Rochester, N. Y.
Dr. Paul Thorndike (1892), 24 Marlborough St., Boston.
Dr. Francis S. Watson (1887), 92 Marlborough St., Boston.
Dr. W. N. Wishard (1889), 723 Hume Mansur Building, Indianapolis.
D. A. C. Wood (1900), 2035 Walnut St., Philadelphia.

ACTIVE MEMBERS

Dr. Nathaniel G. Alcock (1922), Bank Building, Iowa City, Iowa.
Dr. J. Dellinger Barney (1912), 99 Commonwealth Ave., Boston.
Dr. Benjamin S. Barringer (1911), 109 East 34th St., New York.
Dr. Horace Binney (1910), 403 Beacon St., Boston.
Dr. M. L. Boyd (1921), Hurt Building, Atlanta, Ga.
Dr. William F. Braasch (1913), Mayo Clinic, Rochester, Minn.
Dr. Robert C. Bryan (1915), 301 West Grace St., Richmond, Va.
Dr. H. G. Bugbee (1916), 40 East 41st St., New York.
Dr. J. Edward Burns (1922), Waldheim Building, Kansas City, Mo.
Dr. Hugh Cabot (1907), University of Michigan, Ann Arbor, Mich.
Dr. John R. Caulk (1912), Humboldt Building, St. Louis, Mo.

Dr. Arthur B. Cecil (1921), 400 Marsh-Strong Building, Los Angeles, Cal.
Dr. C. H. Chetwood (1900), 25 Park Ave., New York.
Dr. Arthur L. Chute (1909), 352 Marlborough St., Boston.
Dr. J. Bayard Clark (1906), 47 East 57th St., New York.
Dr. J. A. C. Colston (1921), Johns Hopkins Hosp., Baltimore, Md.
Dr. A. H. Crosbie (1916), 520 Commonwealth Ave., Boston.
Dr. A. J. Crowell, (1921), 700 Independence Building, Charlotte, N. C.
Dr. J. H. Cunningham, Jr., (1906), 46 Gloucester St., Boston.
Dr. Edwin Davis (1922), 670 Brandeis Theatre Building, Omaha, Neb.
Dr. Francis C. Edgerton (1906), 57 West 58th St., New York.
Dr. H. A. Fowler (1907), 1621 Connecticut Ave., Washington, D. C.
Dr. William A. Frontz (1920), Professional Building, Baltimore, Md.
Dr. H. G. Fuller (1920), 1615 Florida Ave., Washington, D. C.
Dr. Faxton E. Gardner (1907), 251 West 81st St., New York.
Dr. James A. Gardner (1915), General Electric Building, Buffalo.
Dr. John T. Geraghty (1909), Professional Building, Baltimore.
Dr. George S. Gordon (1920), 127 Vancouver Building, Vancouver, B. C., Canada.
Dr. Francis R. Hagner (1906), The Farragut, Washington, D. C.
Dr. Frank Hinman (1920), Powell and Sutter Sts., San Francisco.
Dr. Joseph Hume (1921), 724 Baronne St., New Orleans, La.
Dr. E. L. Keyes, Jr. (1901), 109 East 34th St., New York.
Dr. H. L. Kretschmer (1916), 122 S. Michigan Boulevard, Chicago.
Dr. Thomas F. Laurie (1922), 608 E. Genesee St., Syracuse, N. Y.
Dr. Louis Lehr (1920), 1737 H. St., N. W., Washington, D. C.
Dr. George R. Livermore (1922), 1308 Exchange Building, Memphis, Tenn.
Dr. William E. Lower (1912), 1021 Prospect Ave., Cleveland, Ohio.
Dr. Oliver Lyons (1920), 453 Metropolitan Building, Denver, Col.
Dr. David W. MacKenzie (1920), 624 Sherbrook St., West, Montreal, P. Q., Canada.
Dr. Henry H. Morton (1900), 32 Shermerhorn St., Brooklyn, N. Y.
Dr. R. F. O'Neil (1909), 374 Marlborough St., Boston.
Dr. Alfred T. Osgood (1906), 40 East 41st St., New York.
Dr. Arthur H. Paine (1922), 35 Chestnut St., Rochester, N. Y.
Dr. James Pedersen (1906), 40 East 41st St., New York.
Dr. W. C. Quinby (1916), Peter Bent Brigham Hospital, Boston.
Dr. Alexander Randall (1920), Medical Arts Building, Philadelphia.
Dr. Nathaniel P. Rathbun (1921), 67 Hanson Place, Brooklyn, N. Y.
Dr. H. L. Sanford (1912), 213 Ball Building, Cleveland, Ohio.
Dr. Louis E. Schmidt (1904), The Mallers Building, Chicago.
Dr. Thomas Shupe (1921), Cleveland Clinic, Euclid Ave. and 93d St., Cleveland.
Dr. E. H. Siter (1913), 1520 Locust St., Philadelphia.
Dr. G. G. Smith (1916), 352 Marlborough St., Boston.
Dr. J. Bentley Squier (1905), 8 East 68th St., New York.
Dr. A. R. Stevens (1916), 40 East 41st St., New York.
Dr. W. W. Townsend (1915), Burlington, Vermont.
Dr. George W. Warren (1915), 117 East 62nd St., New York.
Dr. George S. Whiteside (1907), Journal Building, Portland, Oregon.
Dr. W. P. Willard (1916), 177 Post St., San Francisco.
Dr. H. H. Young (1901), Johns Hopkins Hospital, Baltimore, Md.

In Memoriam

Dr. James Raynor Hayden, Fellow

Dr. George Knowles Swinburne, Fellow

CONTENTS

FIRST DAY

Monday, May 1, 1922

1. Epispadias in Women. Dr. William E. Lower 1
2. Pseudo Hermaphrodism or Complete Hypospadias. Dr. Francis R. Hagner and H. B. Kneale 11
3. Renal Torsion. Dr. William F. Braasch 33
4. Hydronephrosis. Dr. William C. Quinby 43
5. Cases Illustrating the Cause of Hydronephrosis. Dr. Arthur L. Chute 65
6. Some Cases of Hydronephrosis. Dr. Richard F. O'Neil 77
7. Temporary Suppression of Urine Following Double Pyelography. Dr. Henry H. Morton 87
8. Sphincterotomy per Urethram, a Simple and Safe Procedure for the Cure of Contracture of the Vesical Orifice. Dr. J. T. Geraghty 107
9. The Operative Cure of Incontinence of Urine, with Illustrative Cases. Dr. Hugh H. Young 115
10. A New Method of Perineal Prostatectomy Which Insures More Perfect Functional Results. Dr. John T. Geraghty 187
11. Differentiation Between Tuberculous and Non-Tuberculous Inflammation of the Epididymis. Dr. A. R. Stevens 211
12. Tuberculosis of the Adenomatous Prostate. Dr. J. Dellinger Barney 219
13. Pharmacodynamic Reactions of Erectile Tissue and the Dorsalis Penis Artery. Dr. David I. Macht 229

SECOND DAY

Tuesday, May 2, 1922

14. Report of a Case of Schistosomum hematobium. Dr. James Pedersen 231
15. Renal Counterbalance: An Experimental and Clinical Study with Reference to the Significance of Disuse Atrophy. Dr. Frank Hinman 241
16. Report of Cases of Malignant Growths of the Bladder Treated by Resection and Radium. Dr. Henry G. Bugbee 393
17. The Character and Treatment of Bladder Ulcers. Dr. E. L. Keyes, Jr. 413
18. Elusive Ulcer of the Bladder. Dr. H. L. Kretschmer 417
19. The Treatment of Pyelitis. Dr. C. H. Chetwood 443
20. Gonococcal Infections of the Kidney. Dr. J. Dellinger Barney 447
21. Report of a Case of Obliterating Arteritis of a Branch of the Left Renal Artery Supplying the Lower Pole of the Kidney. Dr. Francis C. Edgerton 455
22. Megaloureter: The Importance of the Uretero-vesical Valve. Dr. John R. Caulk 467
23. A Case of Sacral Kidney. Dr. Arthur L. Chute 487
24. A Case of Reduplication of Left Ureter and Left Renal Pelvis. Dr. Richard F. O'Neil 493

THE AMERICAN ASSOCIATION OF GENITO-URINARY SURGEONS

FIRST DAY, MAY 1, 1922

EPISPADIAS IN WOMEN

REPORT OF A CASE

W. E. LOWER

Cleveland, Ohio

Received for publication August 10, 1922

That epispadias in the female is of exceedingly rare occurrence is evidenced by researches into the literature in which we have been able to find reports of only 43 cases. Even among these few there seems to be some difference of opinion as to whether or not all were cases of true epispadias. In fact, there seems to be a considerable difference of opinion as to the exact nature of this anomaly, and many of the textbooks on genito-urinary diseases either omit any mention of the occurrence of this abnormality in women, or else make the definite statement that it occurs only in the male.

According to Ballantyne (1) male and female epispadias do not correspond, the deformity in women consisting essentially in a displacement of the urethra to a point above the level of the clitoris, the bladder walls are intact and the symphysis is closed. It is these latter conditions which differentiate the condition from exstrophy in which there is a defect in the bladder wall and the symphysis is divided. Mayersbach (2) follows Durand and Guyon's division of the various stages of the malformation into four groups:

1. Corpus cavernosum of the clitoris is separated and the urethra merges into the dorsum of the clitoris and resembles more or less the epispadias in the male. This modification occurs more rarely.

2. The urethra merging into the split dorsum of the clitoris, shows various great defects of its anterior (posterior) wall.

3. Any trace of an anterior urethral wall may be lacking and this condition is usually associated with a prolapse of the bladder mucous membrane.

4. Complete abdominal fissure which communicates with the urinary bladder. The symphysis is not closed, the anterior abdominal wall is cleft as far as the bladder cavity; the bladder mucous membrane itself is prolapsed.

The forms of epispadias in the female which occur most frequently fall in groups 2 and 3 and present a rather similar appearance.

Stiles (3) describes the different forms of the lesion in the order of their severity as

Partial epispadias, where the deeper part of the dorsal wall of the urethra is developed; complete epispadias, where the dorsal wall is entirely absent; and sub-symphyseal extroversion, where the sphincter at the neck of the bladder is deficient and there is more or less protrusion below the symphysis of the mucous membrane of the posterior wall of the bladder.

Whatever classification one may adopt, however, has but little bearing upon the treatment to be offered. In any case the outstanding difficulty for which relief is sought is the incontinence of urine, and the method of establishment of an effective means of control does not depend upon the extent of the deformity.

Ballantyne (1) adds to his report of a personal case an analysis of 33 cases reported in the literature. He considers that *14* among these were cases of genuine epispadias; 16 he considers should more properly be classed as cases of "sub-symphysial exstrophy," while in the remaining 3 the classification was uncertain.

Mayersbach (2), writing twelve years later, makes the statement: "Twenty-four cases from the literature, up to 1904, have been reported by Gütschow. To these only a few new ones have been added."

Nové-Josserand and Cotte (4), in 1907 report records of 30 cases to which they append a case of their own.

Accepting Nové-Josserand and Cotte's (4) figures and adding their own case, 1 reported by Mayersbach (2) in 1908, 1 by Göbell in 1910; 2 cases by Stiles (3) in 1911, 1 by Wertheim (5) in 1919, 6 by Schmidt (6) in 1920 and 1 by Reifferscheid (7) in 1921, the total number of reported cases to date would be 43, although as we have stated above there would appear to be some uncertainty regarding the exact classification in all these cases.

ETIOLOGY

As to the developmental conditions which are responsible for this anomaly, we can do no better than quote from Ballantyne (1):

> Chiefly through the researches of F. Tourneux, considerable light has been thrown upon the development of the external genitals. The anal plate which closed in the posterior end of the embryo becomes much thickened, so as to form a mass of epithelial cells which constitutes a sort of plug. The greater part of this plug is called by Tourneux the *bouchon cloacal*, and it intervenes between the lower end of the urogenital sinus and the exterior, and thus shuts in the sinus. On its ventral aspect is an accumulation of cells of the mesenchyma which forms the external prominence known as the genital tubercle, the future clitoris or penis. By the disappearance or breaking down of the cells of the 'bouchon cloacal' the urogenital sinus comes to communicate with the exterior by means of the vulvar and urethral apertures which are thus formed. A prolongation forward of the "bouchon" or plug causes, by its subsequent breaking down, a grooving of the under surface of the genital tubercle, and so leads to the later formation of the urethral canal and vestibule. This prolongation has been called the "urethral lame" by Tourneux, and it is to this structure that we must look for an explanation of the origin of epispadias and vesical exstrophy. According to Durand, the undue extension forward of this "urethral lame," and its groove or orifice-making powers, leads to an increase in the size of the anterior part of the aperture by which the urogenital sinus is put into communication with the exterior. "The urethral walls are, therefore, imperfectly formed, and epispadias is produced and the clitoris is split. A more marked extension of the

"lame" results in the production of an orifice in the anterior bladder wall (sub-symphysial vesical exstrophy); and a still farther extension prevents the closure of the symphysis pubis and the anterior abdominal and vesical walls (vesical exstrophy). This theory may or may not be correct but it has the advantage of explaining in a rational way both epi- and hypospadias and vesical exstrophy.

TREATMENT

As the causative factor in these cases is out of our control it is to the correction of the condition, especially to the restoration of function, that our attention must be directed.

Ballantyne (1) reports the results of plastic surgery as complete cure in 4 cases, great improvement in 8, and amelioration in 3. In none of these cases were the ureters transplanted.

Gersuny (8) reports a successful result from torsion of the urethra, along its longitudinal axis. He made 3 successive operations, in each of which the urethra was twisted through half a circle, and fixed each time in its new position. Continence for five hours was the result of this procedure.

Wojciechowski (9) performed a similar operation making a torsion of the urethra of only 90 degrees, with a like satisfactory result. These end results would appear to have been the best secured by any of the methods used prior to Stiles (3) in his 2 cases in which he transplanted the ureters into the lower part of the pelvic colon. Stiles (3) thus summarizes the prior methods:

> The various methods employed have consisted either simply in narrowing the urethra or in combined narrowing with lengthening. The narrowing was effected either by simple cauterization, by suturing the raw edges obtained by lateral incisions, by urethral colporraphy, or by a plastic operation combined with torsion. A combination of lengthening and narrowing of the urethra was attained in one of three ways: (1) by dissecting down a triangular flap from the muco-cutaneous trough above the abnormal meatus so as to restore the superior wall of the urethra; (2) by the formation of two lateral flaps combined with supra-urethral colporraphy; (3) by combining lengthening with torsion of the urethra.

Schmidt (6) reports satisfactory results in 4 of his 6 cases, 3 of which he reports as complete epispadias and 3 as of "grades 2 and 3," as the result of the construction of an effective sphincter by the method of Goebell-Stoeckell (10). In most of these cases, however, the patients were followed for but brief periods after operation or else the period of cure is not stated. The crucial question is: For what length of time were these methods effective?

In Stiles' (3) 2 cases, excellent results were secured. The first, one year after operation, was completely continent during the day, but occasionally wet the bed at night; the second, three months after operation had "complete continence both day and night;" and in a personal interview a few months ago Stiles (3) refers to one of these cases as still in excellent condition, i.e., eleven years later.

AUTHOR'S CASE

My own case, a woman, thirty years of age, consulted me first in October 28, 1921, complaining of a small lump in her groin, which had been gradually increasing in size during the preceding six months—with accompanying periods of cramplike pains, nausea and vomiting. During these periods the lump which proved to be an inguinal hernia would rapidly enlarge, was sometimes bluish in color and would become very tender. The patient reported that she had never had any control of her urine. Further inquiry elicited the fact that when she was about one year old her parents first realized that the urine was trickling continuously and noted the exposure of a raw surface where the urethra should be. They took her to a doctor who said that the protruding surface was the bladder. When she was three years old a plastic operation was performed, which in part covered the raw surface but did not effect the continuous flow of urine.

Physical examination showed well formed labia majora with the scar of the old operation at the upper junction (fig. 1). There was a separation of the pubic bones but no absence of the abdominal or bladder wall above (fig. 2). However, as a plastic skin (fig. 1) had been made which, as her father stated, covered much of the raw surface, I could not determine the exact extent of the original deformity. The vaginal orifice was the opening of what appeared to be a large urethral fistula,

through which urine trickled continuously. Into this a finger could be inserted and no sphincter muscle could be detected. The thin skin flap could be felt above.

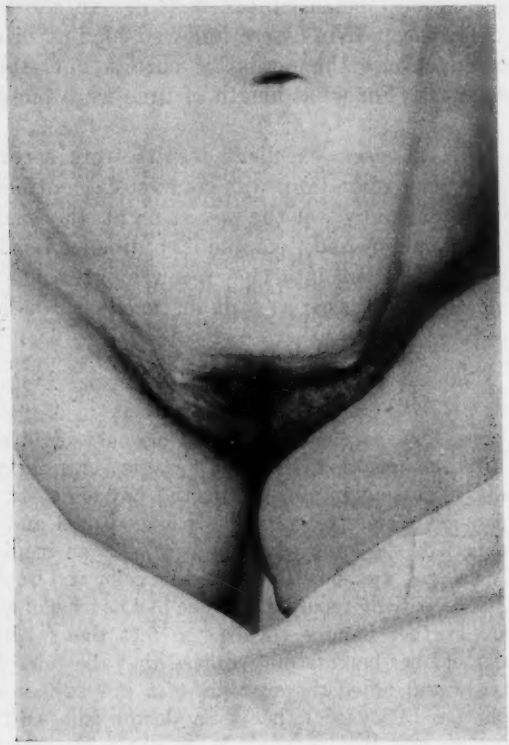


FIG. 1. EPISPADIAS IN A WOMAN

Author's case; external appearance showing scar; plastic operation

The patient, who had accepted her incontinence as a matter of course and supposed it was an unalterable condition, was told that the hernia was of lesser importance and that the condition of incontinence could be corrected by an operation. As she had had an operation without relief she would not consent to another unless she could be assured that it would result in her being able to keep dry. When we

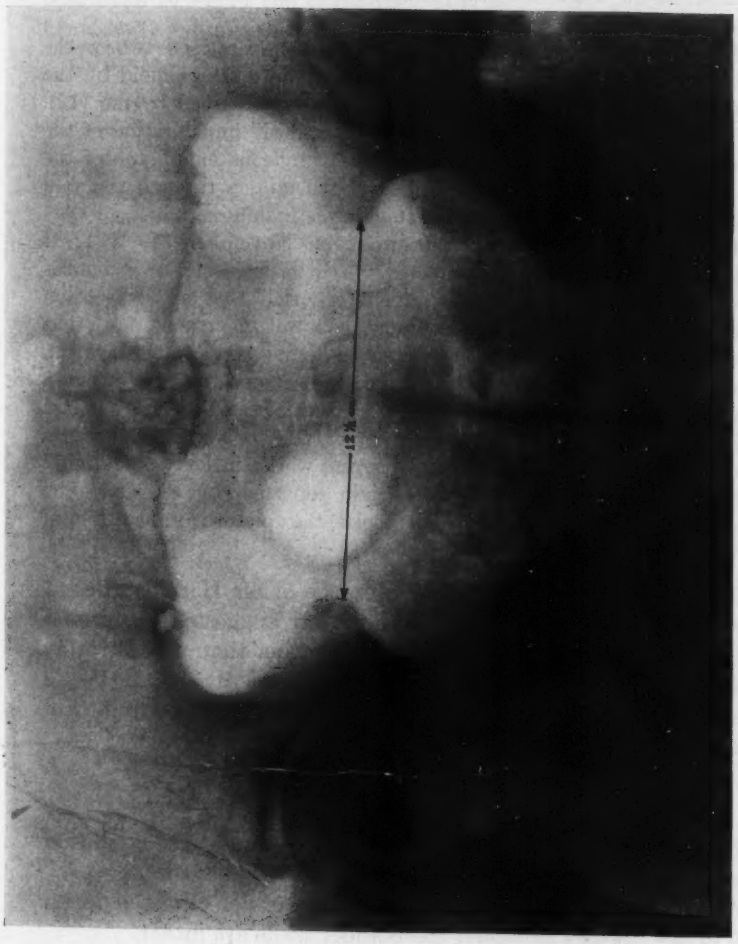


FIG. 2. EPISPADIAS IN A WOMAN
Author's case; Roentgenogram showing separation of the pubic bones

told her that our advice was based upon the successful end-results secured in 15 cases of transplantations of the ureters, she gladly consented.

The ureters were transplanted at separate operations two weeks apart—the right into the rectum and the left into the sigmoid by the method devised by Coffey (11) and previously described by me (12). By this method, which is in effect, "physiological" implantation of the ureters wherein their course underneath the mucous membrane of the gut corresponds to the normal course of the ureters through the wall of the bladder, their physiological function is maintained.

The second operation was performed on November 14, 1921, at which time her hernia was corrected. A little less than two months later, on January 5, 1922, the patient reported that she was often able to get through the night without a bowel movement, and that during the day she had retention for seven hours. On March 24, 1922, four months after the transplantation of the ureters, the patient again reported in excellent condition, stating that she scarcely ever had to get up at night. The change in her mental state was most striking; as she put it "I have lived in a very different world since my operation." One month later, on April 27, she again reported, by request. She is almost exuberantly happy and looks the picture of health and contentment.

Of particular interest was the presence of Sir Harold Stiles at the first transplantation. He immediately suggested the probability that this was a case of epispadias rather than an exstrophy and further examination convinced us that it should be so classified. It was at this time that he made the further report of one of his cases, which we have mentioned above.

SUMMARY

True epispadias in the female is an exceedingly rare condition though it may be more common than we have believed.

We would classify as epispadias any type of defect of the dorsal wall of the urethra provided the bladder walls are intact.

Most plastic operations accomplish little more than a covering of the exposed parts.

Transplantation of the ureters into the large intestine ensures relief from incontinence.

The transplantation of each ureter should be done at a separate operation to avoid the possibility of a temporary suppression of urine and to diminish the postoperative reaction.

REFERENCES

(1) Ballantyne, J. W.: Edinburgh Hosp. Rep., 1896, iv, 249. (Extensive bibliography.)
(2) Mayersbach, L.: Wien. klin. Wchnschr., 1909, xxi.
(3) Stiles, H.: Surg. Gyn. Obs., 1911, xiii, 127.
(4) Nove-Josserand, G., and Cotte, G.: Rev. d. Gyn. et d. Chir. Abd., 1907, xi, 963.
(5) Wertheim: Wien. klin. Wchnschr., 1919, xxxii, 888.
(6) Schmidt, H. R.: Deutsch. med. Wchnschr., 1920, xlvi, 910.
(7) Reifferscheid, K.: Zentralbl. f. Gyn., 1921, xlv, 97.
(8) Gersuny, R.: Centralbl. f. Chir., 1889, xvi, 433.
(9) Wojciechowski, B.: Przegl. lek., Krakow, 1899, xxxviii, 259.
(10) Stoeckell, W.: Zentralbl. f. Gyn., 1917, xli, 11.
(11) Coffee, R. C.: Jour. Amer. Med. Assoc., 1911, lvi, 397.
(12) Lower, W. E.: Jour. Amer. Med. Assoc., 1919, lxxiii, 328; Jour. Amer. Med. Assoc., 1920, lxxv, 711; Ann. Surg., 1921, lxxiii, 354.

PSEUDO HERMAPHRODISM OR COMPLETE HYPOSPADIAS

FRANCIS R. HAGNER AND H. B. KNEALE

Washington, D. C.

Received for publication, August 10, 1922

Compared with lesser degrees of hypospadias, hypospadias perinealis is by far the rarest form. Up to 1917, Carl Beck, who has seen many cases of hypospadias had only observed one case of the complete form and this patient disappeared without operation.

In this severe form the scrotum is bifid. The testicles may or may not have descended and are often small. The penis is poorly developed, usually bent ventrally, imperforate and of no physiological use in its malformed condition. It is often mistaken for an enlarged clitoris, concealed by the scrotal tissues which may resemble the labia majora. The urethral opening is nothing more than an orifice or a gutter in the perineum, lined with mucous membrane.

Mareto and Carpentier have discussed at length the etiology, pathology, symptomatology and treatment of the perineal form of hypospadias. Parkham in the January, 1901, number of the New Orleans Medical and Surgical Journal summarized the literature to date, which as a whole does not encourage operation for the deformity. He has also described various operations with illustrations. He has the following to say concerning complete hypospadias: In the fourth form the deformity reaches its extreme degree, the scrotum being divided into two halves looking so like a labia majora as to deceive one without careful examination. Tillaux in his lectures (Leçons de Clinique Chirurgicale, 1895, p. 367) tells how he came near making a

serious error of this kind. The urethra opens at the bottom of this fissure. It might well be denominated false hermaphrodism.

In this variety coitus is impossible, indeed the more pronounced the erection the more the organ is bent forward. Fecundation, of course, therefore, is out of the realm of possibility.

Micturition is retromingent, and necessitates a squatting position to avoid soiling the clothes. Such a sufferer can, indeed, bless the hand that reconstitutes him a man.

The operations that are applicable to perineal hypospadias are all based on one of the following principles.

First, formation of a new urethra by the use of flaps as advocated by DuPlay, Szymanowski, Russell, Angier and others.

Second, formation of a new urethra by tunnelling and the use of skin grafts according to the method of Nove-Josserand.

Third, formation of a new urethra by transplanting flaps on a pedicle from the prepuce and skin of the dorsum of the penis according to the method of Mayo.

The operations of DuPlay and Nove-Josserand are well described with illustrations in Cabot's Modern Urology.

Two procedures are essential to all methods, namely, straightening of the penis and preliminary drainage through the perineal fistula or suprapubic cystostomy, before the formation of the new urethra. A period of several months should intervene between the time of straightening the penis and the plastic reconstruction of the urethra to allow for any subsequent cicatrization.

The age of the patient is an important factor. Some surgeons advocate early operation but the consensus of opinion favors surgical intervention between the sixth and ninth years when the operator can gain the coöperation of the patient.

In reviewing available literature at the Surgeon General's Library 25 cases of complete hypospadias have been found which have been subjected to operation. As a whole the recorded results have been good. Undesirable results have been:

First, postoperative fistulae along the course of the newly formed urethra in 6 cases, the majority of which finally closed.

Second, incurvation of the penis on erection in 1 case.

Third, failure of erection in 1 case.

Fourth, bending forward of the penis on erection in 1 case.

The almost uniformily satisfactory results obtained in the cases reviewed are probably misleading, when all cases of perineal hypospadias are considered, as undoubtedly *more unsuccessful* operative attempts have been made, that have *not been* reported, than successful operations that have been reported.

This patient was first brought to me in 1908 when he was two years old. Family history was negative for any deformity in either paternal or maternal ancestors.

When the child was born it was first thought to be a girl by the attending physician but later it was discovered that some abnormality of the sexual organs was present.

At the time of my examination he was a well nourished wholesome looking baby. On inspection of the genital organs there was every appearance of a female child with a large clitoris, the urethral opening having the appearance of a small vagina, neither testicle was down nor could they be palpated in the inguinal canal. The folds on each side gave the typical appearance of a vulva as shown in this drawing.

On close inspection of the clitoris-like glans, it was noted that the whole penis was covered with tissue except the glans, it, being firmly bound down and immobile. There is no attempt of a formation of a bulbous urethra, the opening in the perineum leading to the bladder which was easily catheterized being the beginning of the membranous urethra.

I saw this child at regular intervals until he was nine years of age—at this time I dissected the glans and corpora cavernosa from its surrounding tissues which so firmly bound it down making it immobile. A plastic operation being done to cover the top of the penis with skin and the bed from which it had been removed. This healed readily. There was no infection from the urine which escaped from the urethra located well down in the perineum. As soon as the wound had healed I had the mother every day take hold of the organ and make traction upward and forward to give it length and to overcome any tendency to curvature and as this was a very miserable looking penis at this time I cannot help but feel that this had a great bearing on the ultimate result in this case, and it is a feature that has not been brought out in the cases previously reported. This treatment was continued until

1917. At this time the penis had grown considerably, both in length and size. His left testicle had been down for over a year, the testicle being normal and well formed. Examination failed to elicit any evidence of the presence of a testicle on the right side. As the boy was now eleven years old and was perfectly willing to help in every way it was decided to begin the building of a urethra.

There was no mucous membrane to work with as there was no vestige of mucous membrane on the under surface of the penis as is

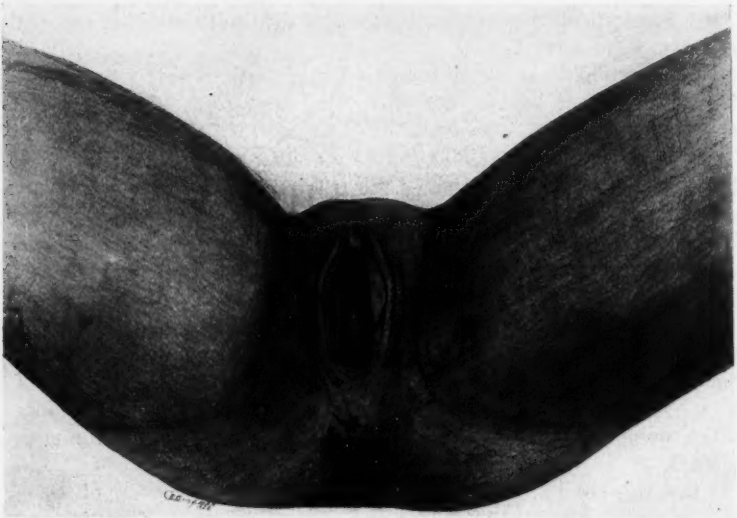


FIG. 1. CONDITION PRESENT BEFORE OPERATION

seen in cases of penile hypospadias. The under surface of the organ being perfectly flat with no sulcus at any point.

The accompanying photographs taken at this time show the condition presented at the time of operation, but the penis, while it appears in the pictures to have incurvation (on account of the continued stretching referred to before) was more apparent than real.

In collecting literature of cases operated on for complete hypospadias, we find hardly any two have been done exactly in the

same way. This is probably due to the different conditions existing in different cases. The one that appealed to Dr. Fuller

FIG. 2. CONDITION PRESENT AFTER FREEING PENIS BEFORE ATTEMPT TO BUILD URETHRA

and me was an operation borrowed from the surgeons who operate on cleft palate—the idea being to form a large urethra that would not contract and would not have to be dilated to prevent

its closure. (This boy at the present time has a made urethra that will admit over a 30 sound to the bulbo membranous junc-

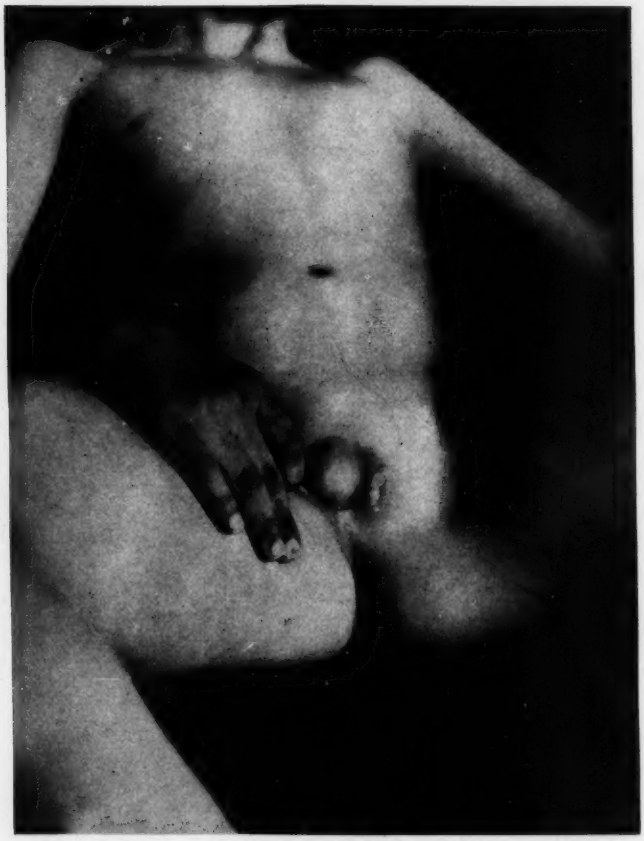


FIG. 3. CONDITION PRESENT AFTER FREEING PENIS BEFORE ATTEMPT TO BUILD URETHRA

ture.) Furthermore we were anxious to have no pulling or shortening of the urethra to cause a tendency to incurvation.

The first operation was performed in February, 1917, which consisted in an attempt to make a floor for the urethra from just behind the glans to within 2 cm. of the urethral opening in the perineum. This opening of the urethra being the entrance to the membranous urethra as indicated before.

An incision was made well over on the left side of the penis and carried back the whole side of the organ and the perineum down to within 2 cm. of the urethral opening. The flap was dissected toward the median line to a point almost to the apex of the urethra. At each end of the longitudinal incision, necessary right angle incisions were made to permit the flap to fold over. The width of this flap was over 2 cm. Another longitudinal incision of equal length was made just to the right of the median line of the under surface of the penis, the flaps containing the skin and subcutaneous tissue. This flap was freed from the median line to the right, a distance to correspond with that on the left; and right angle incisions being made at each end to correspond to the width of the flap. The left hand flap was folded over a silver tube that extended from the glans posterior to 2 cm. from the perineal opening of the membranous urethra, and sutured with fine silver wire to the body of the penis, the silver wire passing through the skin of the left hand flap at its fixed border. After these sutures were placed they were twisted over small strips of gauze to prevent cutting the skin by the wire. This procedure made the inside of the urethra of skin. The freed right hand flap was brought over the raw surface of the left hand flap which formed the urethra and sutured with silver wire at the margin where the left hand flap had been cut. This procedure made a skin covering so no grandulation tissue was exposed. The ends of the new urethra were then sutured by interrupted fine silver wire. This was covered by silver foil and a small de pezza catheter introduced through the urethra for drainage. This healed perfectly except at one or two points where sutures pulled out, the edges having to be freshened and resutured later. At completion of healing the perineal drainage was removed.

The result of this operation was that the patient had a patulous urethra of skin extending from the glans to 2 cm. anterior to the perineal opening.

On June 4, 1917, four months later, an attempt was made to make a bulbous urethra and attach it to the penile urethra, a suprapubic cystostomy was done for drainage.

Summary of cases operated upon for hypospadia perinealis found in available literature

AUTHOR	PATIENT'S AGE	METHOD	DRAINAGE	RESULT
Brown and Ishmael		Tunnelization and insertion of catheter, constantly worn until mucous lining formed; later worn for several hours daily to prevent contraction. Closure of perineal fistula	Not stated	Good. Wife became pregnant
Lewis		Scrotal flaps	Not stated	Fair. Bending forward of penis on erection
DuPlay		Straightening of penis. Formation of urethra with lateral flaps, sutured over catheter, six months later. Closure of fistula	Perineal	Good
Lutaud		DuPlay's method (three stages)	Perineal	Good
Luecke	20	DuPlay's method	Perineal	Excellent
Waltz	9	DuPlay's method	Perineal	Good. Several operations had to be performed to close persistent fistula
Karewski		Formation of urethra with lateral flaps	Perineal	Fair. Penis buried in scrotum
Peple	13	Straightening of penis. Formation of urethra with lateral flaps. Closure of perineal meatus	Not stated	Good
Pousson		DuPlay's method	Perineal	Good
Walther	13	Formation of urethra from grafts from thigh and tunnelization. Nove-Josserand method	Not stated	Good
Pousson	33	Formation of urethra with penile and preputial flaps	Not stated	Good
Montegnacco	7	DuPlay's method	Perineal	Good
Russell	9	Russell's method. "Clergyman's stole" flap	Suprapubic	Good. Small fistula in middle third of penile urethra which could be closed by traction on penis and thereby prevent leakage

Mayo, C. H.	6	Tunnelization. Formation of urethra with flap from prepuce and skin of dorsum of penis on a pedicle. Joining of urethra. Closure of fistula if necessary	Perineal	Good
Martin	12	Straightening of penis and longitudinal division of corpora cavernosa. Covering raw area with Thiersch graft. After graft took edges of graft were freed and sutured over catheter, forming urethra. Lateral flaps covered over newly formed urethra	Perineal	Not stated
Curtis	10	Straightening of penis (1897). Formation of urethra with flaps (Szymanowski method)	Perineal	Good. Fistula persisted for a time but finally closed
Woolsey	50	Formation of urethra with flaps (Szymanowski method)	Not stated	Good
Nove-Josserand	15	Tunnelization. Formation of urethra with graft from thigh	Perineal	Good. Temporary fistula
Nove-Josserand	6	Above method	Perineal	Fair. No erections
Marion		DuPlay's method	Suprapubic	Good
Nove-Josserand	15	Tunnelization. Formation of urethra with flap from perineum	Perineal	Good
Russell Thompson	8	Russell's method	Suprapubic	Fair. Two fistulae occurred in penile urethra
Thompson	7	Russell's method	Suprapubic	Opening in mid part of penile urethra after two unsuccessful attempts at closure. Failure due to erections
Tissot	6	DuPlay's method	Perineal	Good

An elliptical incision beginning made at the sides of the new made urethra was carried posteriorly around the opening of the posterior urethra almost to the anus and finished at the opening of the urethra

FIG. 4. CUTTING OF FLAPS FOR FORMATION OF PENDULOUS URETHRA

on the opposite side. This was freed so that the posterior portion of the flap could be brought over to meet the new formed urethra. Lateral incisions were then made, freeing the skin over the perineum so it could

be drawn to cover the raw surface of the flap that formed the bulbous urethra. Silver wire sutures were used in the same manner as in the repair of the penile urethra coming through the skin covering so they could be removed.

FIG. 5. FLAP IN PLACE. SILVER WIRE PASSING THROUGH OUTSIDE FLAP SO AS TO FACILITATE REMOVAL

The edges of the posterior end of the newly made penile urethra were freshened, the surface denuded of skin, so as to insure healing of the flaps forming the bulbous urethra, at the points of juncture, the

silver wire sutures being used, so placed that all could be removed. This was covered with silver foil and dressings applied. There was never any breaking down at this point. The suprapubic tube was

FIG. 6. COMPLETION OF PENDULOUS URETHRA

removed in two weeks and a week later the patient was voiding through the new urethra.

At this time I started to make an anastomosis between the anterior end of the urethra and the glans, an opening being made in the glans

and a flap of skin being brought through and sutured with the idea of later making this anastomosis but as the boy had a useful penis both for urinating and copulating with no incurvation on erection we felt it

FIG. 7. INCISION TO FORM BULBOUS URETHRA

best, to let well enough alone as we feared this might lead to incurvation and would necessitate frequent dilatation to keep the opening in the glans from closing.

His present condition is as follows: He voids a good full stream of perfectly normal urine, the only abnormality being that he has to shake the organ well to prevent any dropping of urine on his clothes. This

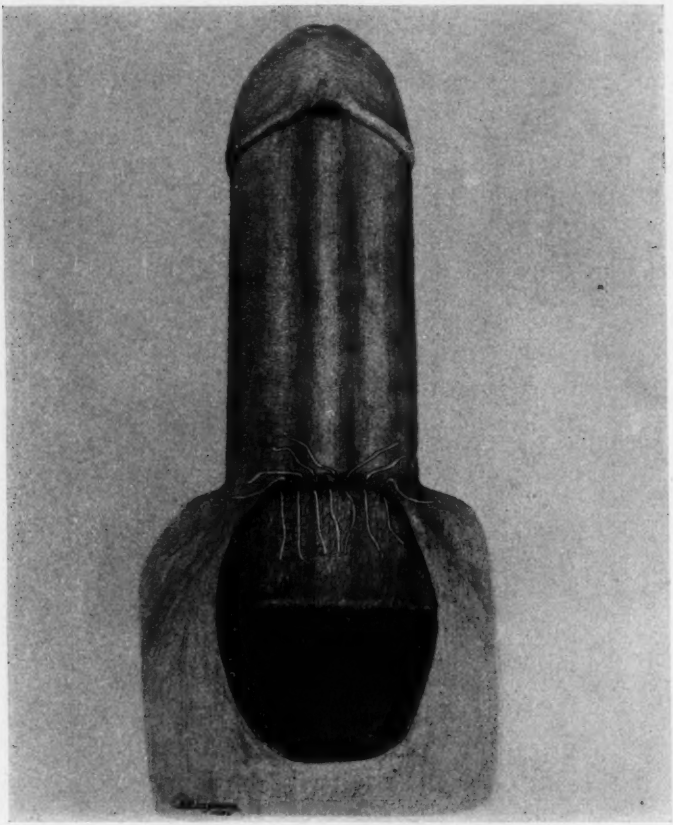


FIG. 8. FIRST STEP IN SUTURING FLAP TO FORM BULBOUS URETHRA

is probably caused by our inability to produce the normal elasticity of the pendulous urethra. A 30 sound can be readily passed to the bulbo membranous juncture and a 20 sound passed into the bladder.

His erections are normal without incurvation.

The results in this case are due to the following conditions: First, the patient was seen early.

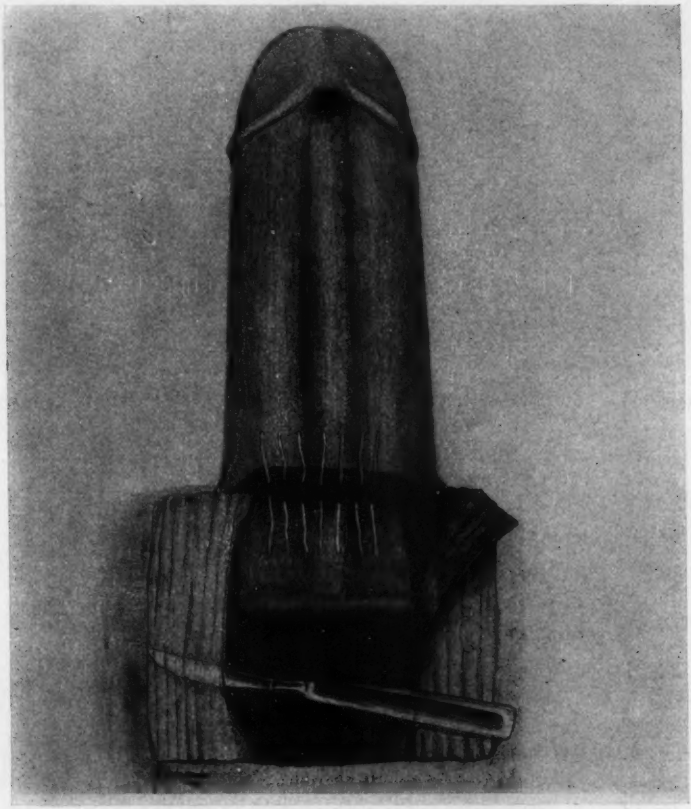


FIG. 9. CUTTING OF LATERAL FLAP TO FORM BULBOUS URETHRA

Second, the freeing of the penis and the stretching of the organ.

Third, not trying to do too much at one time—allowing the parts to become adjusted between operations.

Fourth, making large flaps thus avoiding tension and the placing of the sutures so no two rows were in the same plane.

Fifth, not attempting to drain through the made urethra.

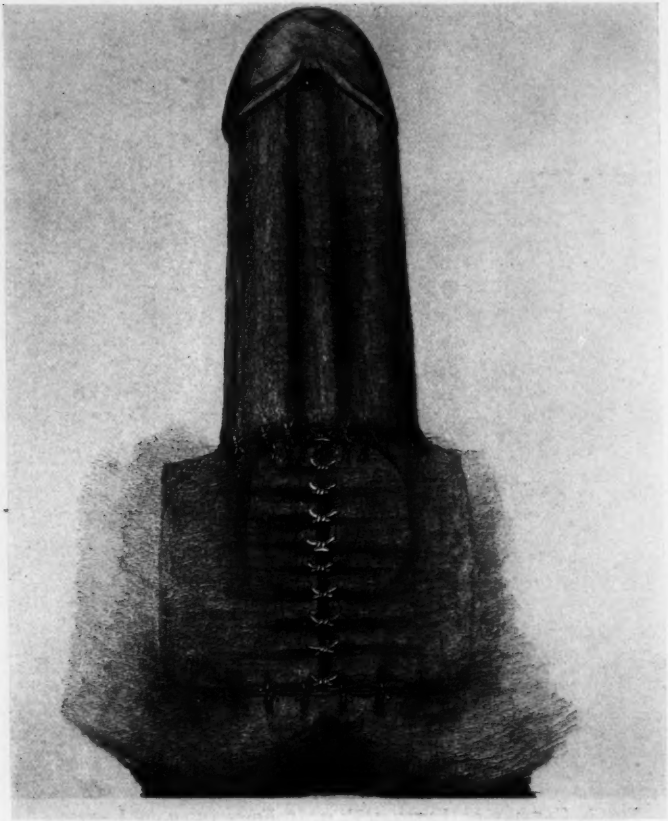


FIG. 10. COMPLETION OF SUTURE TO FORM BULBOUS URETHRA

Sixth, not attempting the repair operation on the urethra before the child was old enough to understand the importance of following directions.

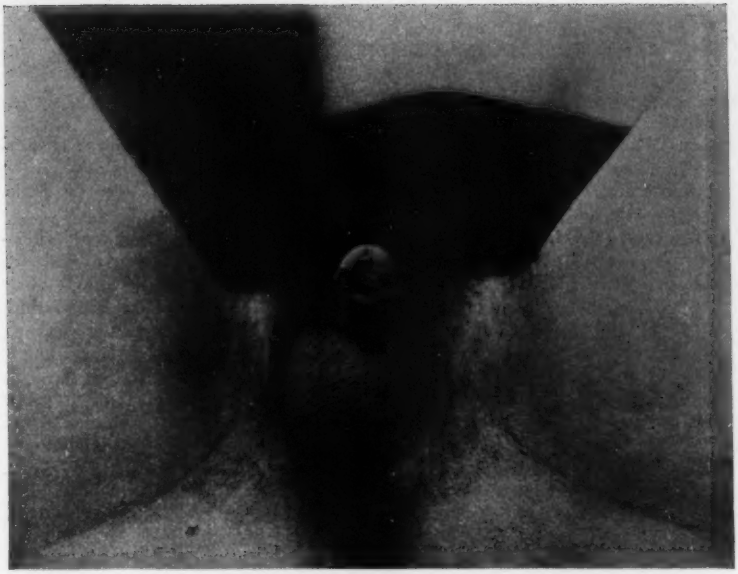


FIG. 11. COMPLETED OPERATION. URETHRA OPENING JUST BELOW NORMAL LOCATION OF NORMAL URETHRA

FIG. 12. PENIS LIFTED UP SHOWING NO INCURVATION

REFERENCES

BECK, CARL: Hypospadias and its treatment. Surgery, Gynecology and Obstetrics, xxiv, 511–532, May, 1917.

MARETO: Du Traitement de l'hypospadias périnéo-scrotal. Thèse de Paris, 1898.

CARPENTIER, C. H. J.: Sur le traitement chirurgical de l'hypospadias périnéo-scrotal. Thèse de Bordeaux, 1892.

PARHAM, F. W.: Hypospadias and epispadias with special reference to their operative treatment. New Orleans Medical and Surgical Journal, xiii, 373–403, January, 1901.

FOWLER, H. A.: Modern Urology. Cabot, Philadelphia and New York, Lea & Febiger, 1918, 207, 209–211.

CURTIS, B. F.: Hypospadias, plastic operations. Transactions of the New York Surgical Society, Annals of Surgery, xxxix, no. 6, 1007–1008, June, 1904.

RUSSELL, R. H.: Operation for hypospadias. Annals of Surgery, xlvi, no. 2, 244–258, August, 1907.

MAYO, C. H.: Hypospadias. Jour. Amer. Med. Assoc., xxxvi no. 17, 1157–1162, April 27, 1901.

LEWIS, B.: A case of complete hypospadias, urethroplasty, recovery. The Medical Herald, St. Joseph, Mo., xvii, no., 1, 16–18, January, 1898.

BROWN AND ISHMAEL: A chase of complete hypospadias, operation, recovery. Richmond and Louisville Medical Journal, xvi, 577, November, 1873.

PEPLE, M. L.: The Clinic Bulletin, Richmond, Virginia, v, no. 1, 22–23, January 1900.

THOMPSON, J. E.: Hypospadias. Surgery, Gynecology and Obstetrics, xxv, no. 4, 411–422, October, 1917.

MARTIN, E. D.: A suggestion in operations for hypospadias and a method to prevent closure of nares in rhinoplasty. Transactions of the Southern Surgical and Gynecological Association, xvi, 397–402, December, 1903.

RUSSELL, R. H.: Operation for severe hypospadias. British Medical Journal, ii, 1432–1435, November 17, 1900.

POUSSON, A.: Opération d'hypospadias périnéo-scrotal en une suele séance. Bulletins et Mémoires de la Société de Chirurgie de Paris, xviii, n. s., 432, Juin 15, 1892.

KAREWSKI: Ueber einen geheilten Fall von Hypospadia perinealis und über eine bei Kindern typische Form von Penisfisteln. Verhandlungen der Deutschen Gesellschaft für Chirurgie, 20th Congress, 295–304, April 3, 1891.

LÜCKE: Ueber einen Fall von perinealer Hypospadia. Verhandlungen der Deutsche Gesellschaft für Chirurgie, 6th Congress, 142, April 7, 1877.

NOVÉ-JOSSERAND: Hypospadias périnéo-scrotal total Guéri par le Procédé de la Greffe autoplastique. Bulletin de la Société de Chirurgie de Lyon, viii, 343–347, Decembre 28, 1905.

NOVÉ-JOSSERAND: Hypospadias perineal Opere par la Methode de la Greffe autoplastique. Société de Chirurgie de Lyon (Session, January 8, 1908). Lyon Medical, cx, 256, 1908.

DU PLAY, S.: De l'Hypospadias Périnéo-scrotal et de son Traitement Chirurical. Archives Générales de Médècine, 6th series, xxiii, 513–530, 657–681, Mai & Juin, 1874.

WAITZ, H.: Ein Fall von geheilter Hypospadia perinealis, Deutsche Medicinische Wochenschrift, xxv, no. 19, 298–299, Mai 11, 1899.

MONTEGNACCO, A.: Ipospadia perineale. Uretroplastica. Guarigione. Atti dell Associazione Medica, Lombarda (Session, January 30, 1896) 14–23, 1896.

LUTAUD, A.: Du Play's operative for the treatment of perineo-scrotal hypospadias. Medical Times and Gazette, i, 630, 1875.

MARION, M.: Hypospadias périnéo-scrotal. Bulletins et Mémoires de la Société de Chirurgie de Paris, xl, n. s., 115, Janvier 28, 1914.

NOVÉ-JOSSERAND: Hypospadias périnéo-scrotal total Guéri par le Procédé de la greffe autoplastique. Lyon Medical, cvi, 332–336, Février 18, 1906.

POUSSON, M.: Gazette Hebdomadaire des Sciences Médicales, xxxiv, no 30, 358, Juillet 27, 1913.

DISCUSSION

Dr. Hugh Cabot, Ann Arbor, Mich.: I want to discuss Dr. Lower's paper because I happen to see some of these cases. I have seen (3) cases which have been operated upon, neither of them was as extreme as Dr. Lower's case, and I have to confess to being in doubt whether this was not a minor degree of exstrophy than epispadias. The cases I have seen have had a patulous urethra, the finger could be passed readily into the bladder. The floor was complete, and there was a gap on the roof. In one of the three the bone was complete. In the other two there was only a slight gap. It appears to me that in those cases an operation similar—somewhat similar—to that which one does for acquired incontinence in the female is applicable by the entire freeing of the vesical neck and pulling down of the bladder and then the creation of the sphincter out of the lower segment of the bladder itself.

Out of the 3 cases operated upon 1 had been made worse by a previous operation in which sloughing occurred. And 1 of the other 2 was a satisfactory cure in which there was complete control though for a slighter period than normal, and in the other the control was subcomplete; that is, there were occasional leakings at night. But I had a feeling there could be a better result obtained and that there is a group of the lesser deformities to which the operation directed to the muscular structures of the bladder itself is likely to be satisfactory, and the operation of transplantation need not be entertained until a previous operation has been done.

The important point is the entire mobilization of the lower segment of the bladder so that one can deal directly with this portion of the bladder. I think there is a minor group in which this operation can be satisfactorily employed.

Dr. Squier, New York: I think that we are all forced to admire the result which Dr. Hagner has obtained. There is not much to

say in the discussion except words in commendation of it. How many of us can say we had had results comparable to this?

Dr. H. G. Fuller, Washington: I think it is fortunate we have seen the patient here to see the end result. I feel fortunate in having seen the case in all of its stages and seen the wonderful advancement from stage to stage in having watched Dr. Hagner in his devotion to this child's welfare and in his development. The little fellow is now, as we have seen, able to stand up and urinate—something that all boys take a delight in; and enough of the erectile tissue has been saved so that he can have erections and copulate. The great success that Dr. Hagner has had, as he has tersely stated, is due to coöperation on the part of the child and on the part of the child's parents. The fact that there were not too many operations and not too much was done at any one time is important, and the fact that the stitches were placed nowhere with two rows in the same plane.

I feel that Dr. Hagner has been richly rewarded, and I feel that it will not be too long before there will be a greater reward and the boy will have offspring.

Dr. W. E. Lower, Cleveland: I think if my case had not been operated upon without success previously, I would have considered a plastic operation on the urethra. I felt sure the transplantation of the ureters would give the hoped for relief from urinary incontinence so I decided upon that type of operation.

Dr. Hagner is to be congratulated upon this interesting case. I am glad he spoke of not trying to do a glandular epispadias. In my opinion it is well to leave this condition alone.

Dr. Francis R. Hagner, Washington: I have not anything to add except that I do believe that in plastic operations nothing is better than fine silver wire. I know that it causes less irritation to the skin than anything we can use. If they are so placed that they can be removed, they are a very valuable thing in plastic surgery.

This boy, if you notice his legs and general contour, is rather of the feminine type, as though nature had not fully made up her mind to make him a boy or a girl in the beginning.

RENAL TORSION

WILLIAM F. BRAASCH

Section on Urology, Mayo Clinic, Rochester, Minnesota

Received for publication August 10, 1922

The normal position of the kidney as described in Gray's Anatomy is as follows: "The kidneys are situated on either side of the vertebral column so that their upper extremities are on a level with the upper border of the twelfth thoracic vertebra, their lower extremities on a level with the third lumbar. The long axis of each kidney is directed downward and lateralward, the transverse axis backward and lateralward." The position of the kidney is further described as being such that the hilum lies opposite the anterior surface of the vertebral column in an anterolateral position, the pelvis being next to the median line and the calyces extending laterally from it. It will be remembered that in the embryo the mass of nephrogenic tissue with the ureteral buds ascends gradually from the bony pelvis until it reaches its normal lumbar position when the embryo has attained a length of approximately 10 mm. As it approaches the permanent position the kidney rotates so that the hilum and the renal pelvis, which were situated anteriorly, now lie adjacent to the vertebrae. Similarly the ureter, which during its ascent extends directly caudad to the anterior aspect of the pelvis, with normal rotation assumes a relatively median position.

Not infrequently in the course of pyelography, abdominal exploration, or necropsy, a marked deviation from the normal in the relative position of pelvis and calyces is found. Instead of the normal degree of rotation, the kidney may be situated so that the pelvis lies entirely anterior to the calyces, or the normal

relations may even be reversed so that the calyces are median to the lateral lying pelvis. Such renal torsion may be of two types, congenital and acquired. In the early embryo the relative position of the embryonic renal pelvis to mesonephric renal cells is such that the former lies distinctly anterior to the latter. With congenital anomaly of position, such as occurs with ectopic and fused kidneys, the embryonic renal tissue is permanently arrested in its ascent, and the pelvis retains the relatively anterior position. When, however, one pole of the fused kidney ascends to a relatively normal position, as often occurs, its pelvis may partially rotate and assume a more normal position. The position of the kidney arrested in its ascent may also be affected by the blood supply. When the renal artery arises from the iliac arteries, as occurs with true ectopic kidney and occasionally with fused kidney, the short pedicle may exaggerate the anomaly in position. Occasionally a kidney is observed which is not truly ectopic, since its blood supply does not arise from the iliac arteries but from the aorta. The kidney is not in the pelvis, but it may be fixed at a level distinctly lower than normal. Normal rotation has not occurred and the renal pelvis remains distinctly anterior (fig. 1).

Owing to differences in the rate of development of the two segments of a fused kidney, as well as to other factors, the renal pelvis may be situated so that there is a complete reversal of the normal relative position of pelvis and calices (fig. 2). As a result the pelvis is situated laterally and the calices extend toward the median line. With failure of rotation and anomalous renal position, the ureter may be situated so that it leaves the renal pelvis from its lateral instead of median border (fig. 3).

Renal torsion may result from factors other than congenital, which may best be termed acquired. The most common factors causing rotation of the kidney are renal ptosis, extrarenal pressure, intrarenal tumor, perinephritis, and trauma.

Renal ptosis. Acquired renal ptosis may be the result of many factors, floating kidney probably being the most common. As might be expected with a freely movable kidney, its long axis is often changed from the normal vertical status so that the pelvis

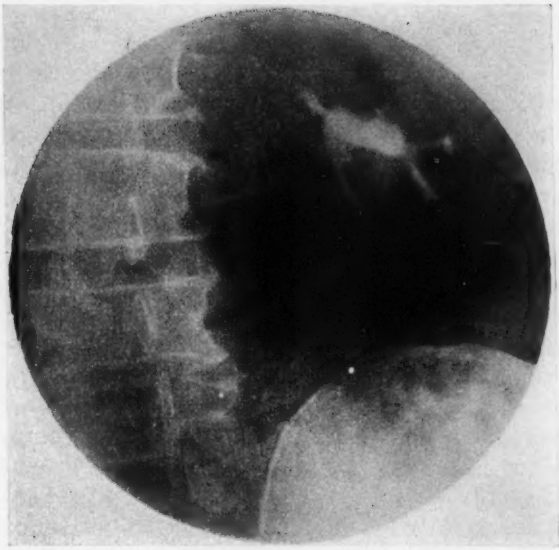


FIG. 1. ANTERIOR ROTATION OF THE PELVIS WITH TORSION OF CALYCES IN HORSE-SHOE KIDNEY

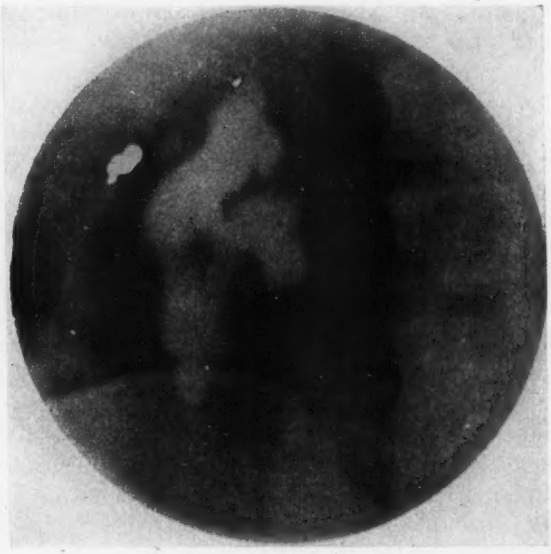


FIG. 2. COMPLETE REVERSION OF CALYCES AS A RESULT OF TORSION WITH FUSED KIDNEY

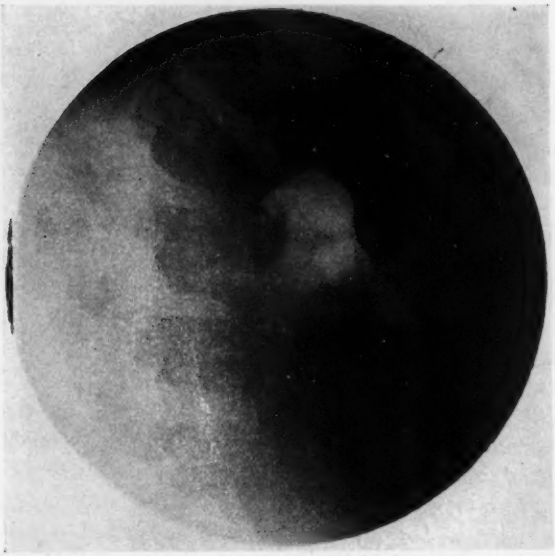


FIG. 3. TORSION RESULTING FROM FUSED KIDNEY

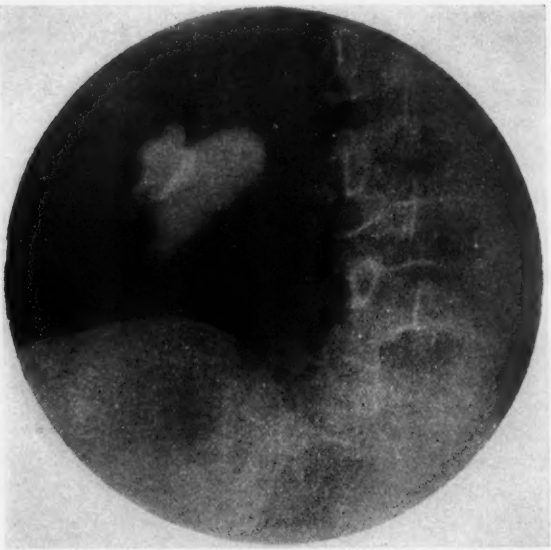


FIG. 4. MODERATE DEGREE OF TORSION AS A RESULT OF PTOSIS

may extend horizontally. With it there is often rotation of the pelvis from its normal median position to an anterior or even lateral position (fig. 4). A slight degree of dilatation of the calyces, and even to a less extent, dilatation of the pelvis may often be observed with the torsion. To what extent the anomalous position of the pelvis resulting from ptosis actually obstructs urinary drainage is open to question. The acute attacks of abdominal pain, or so-called Dietl's crises, which are often noted with renal ptosis, lead one to infer that the abnormal position might well be a factor. Furthermore, the dilatation of the minor calyces, and, to a more moderate degree of the major calyces and true pelvis, which is often observed strengthens the theory of actual obstruction. Nevertheless, at operation there is frequently no evidence that the rotated kidney has caused actual constriction of the ureter. It would be logical to assume that another factor, such as the pressure of an extrarenal organ or band of tissue, is the direct cause of temporary obstruction and that ptosis is only a secondary factor.

Extrarenal pressure. Displacement of the kidney as a result of extrarenal pressure may be caused by extrarenal tumor, perinephritis, and spinal deformity. The kidney may be displaced in any direction by an extrarenal tumor. As a result it is not unusual to find it over the vertebrae under the tenth or eleventh rib (fig. 5) or in the bony pelvis. At the same time there is frequently more or less torsion. With the rotation of the renal pelvis there may be a definite narrowing of the lumen as the result of pressure from the extrarenal tumor (fig. 6). The resulting deformity may occasionally be difficult to distinguish from deformity subsequent to intrarenal tumor.

Intrarenal tumor. Intrarenal tumor occasionally causes torsion of the renal pelvis either as a result of displacement or by actual encroachment on the pelvis by the invading tumor. A large solitary cyst in one pole of the kidney may change the normal axis of the pelvis, or at least of one or more calyces.

Perinephritis and trauma. With marked perinephritis and subsequent cicatricial retraction a considerable degree of renal rotation may be observed. This is often illustrated by the

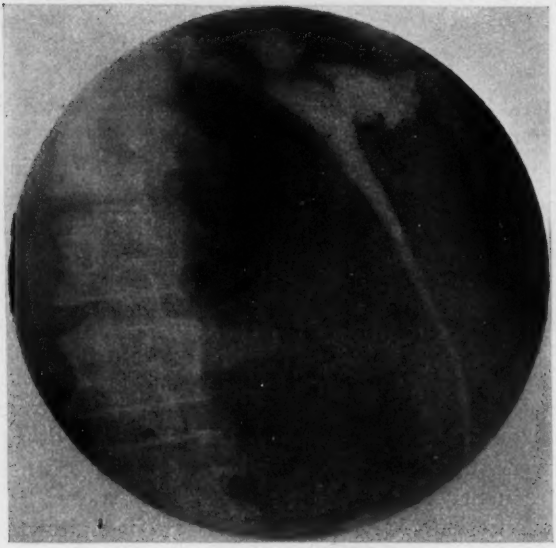


FIG. 5. UPPER DISPLACEMENT OF THE RENAL PELVIS WITH TORSION OF CALYCES RESULTING FROM PANCREATIC CYST

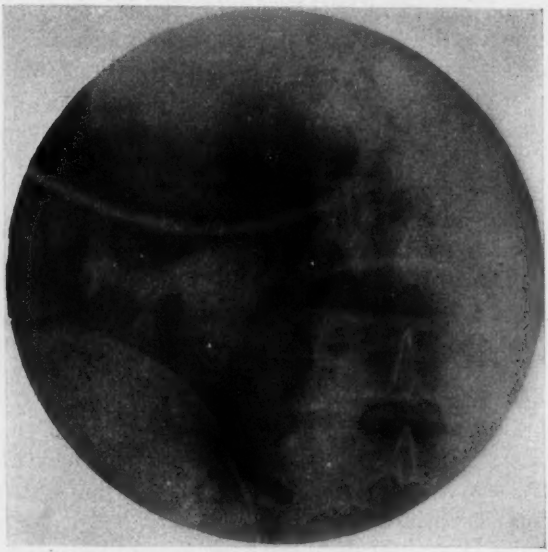


FIG. 6. TORSION AS A RESULT OF DISPLACEMENT BY AN OVERLYING EXTRARENAL TUMOR

unusual position in which an infected kidney is found at operation when it is surrounded by fibrous adhesions which have resulted from extensive perinephritis. A pyelogram made following nephrolithotomy often shows considerable torsion resulting from the manipulation of the kidney. With trauma of the spine and consequent perispondylitis the position of the kidney may be affected either directly by the exudate or by the cicatrix resulting

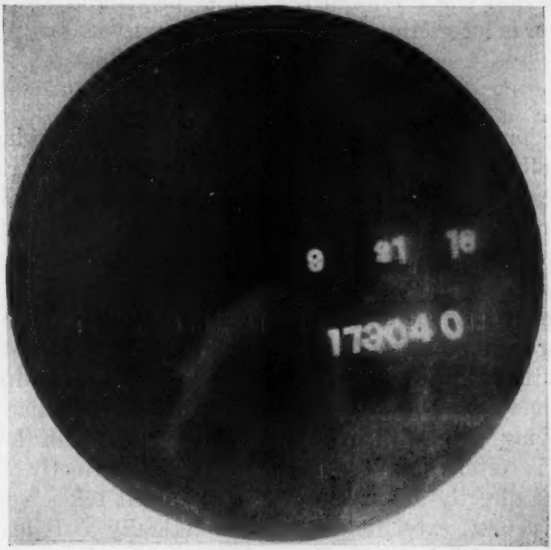


FIG. 7. DISPLACEMENT OF THE RENAL PELVIS, WITH TORSION AND OBLITERATION OF CALICES AS A RESULT OF INTRARENAL TUMOR

(fig. 7). Extensive pleuritic effusions may cause displacement of the kidney. As a result of renal trauma the kidney may be deformed, which, with perirenal cicatricial retraction, may cause marked renal torsion.

CLINICAL SIGNIFICANCE

The existence of renal torsion per se is not of great clinical significance; nevertheless, it may be a factor in the etiology of

hydronephrosis which so often develops with fused and ectopic kidneys. The acute angle at which the ureter leaves the anterior-lying pelvis might well be a factor. Acquired torsion is even less often of clinical significance, although in some cases it is the only factor which can be discovered to account for the evidence of urinary obstruction. If, with marked rotation of the renal pelvis, there is also fixation of the upper ureter it would seem probable that the abnormal relation of pelvis and ureter might be a factor in interfering with urinary drainage.

DIAGNOSIS

On abdominal palpation the anteriorly rotated kidney may occasionally be felt through a soft thin abdomen as a ridge-like mass. As a rule, however, the clinical diagnosis of renal torsion can be made only by means of pyelography. The abnormal position of the rotated pelvis is usually readily recognized in the pyelogram. In the anterior-lying pelvis the outline of the calyces may be superimposed on that of the pelvis so that a confusing picture results. As a rule, however, the calices are either outlined head-on by round areas of accentuated density, or they may be observed extending distinctly median to the lateral lying pelvis. The ureter, particularly with horseshoe kidney, is often seen leaving the pelvis distinctly laterally instead of directly anteriorly. Occasionally it takes a winding, irregular course, extending upward or laterally as it leaves the renal pelvis. With acquired renal ptosis a wide range of abnormal rotations of the pelvis may be observed. Tilting of the pelvis from its usual perpendicular axis is common. Rotation so that the pelvis is situated anteriorly is also often observed. Occasionally the torsion is complete and the normal lateral position of the calices is reversed. Displacement by extrarenal factors is not uncommon. As a result of extrarenal tumor the pelvis may not alone be displaced in any direction, but abnormal rotation is not uncommon, although it seldom occurs to the degree observed with anomaly and is seldom sufficient to cause urinary obstruction. Demonstration of torsion of the renal

pelvis may be the only evidence of the perinephritic nature of the tumor in the flank. As a result of trauma to the kidney or to the spine, or of perispondylitis, the pelvis may be fixed in an abnormal position after the acute symptoms have subsided. Occasionally rotation with a moderate degree of dilatation of the pelvis is observed following a fall, or a blow over the kidney, even though there may have been no actual rupture of the kidney. This condition has been termed traumatic hydronephrosis (1). Similarly, rotation without ptosis together with a moderate degree of hydronephrosis is occasionally observed when no definite clinical etiologic factors or history of trauma are present. With this condition the severity of the clinical symptoms may be much greater than the degree of dilatation or rotation warrants.

REPORTS OF CASES

Case 1 (*A381345*). Mrs. P. R. B., aged forty-two years, came to the Clinic complaining chiefly of attacks of pain originating in the left loin and radiating anteriorly. The pain was so severe that chloroform was used for relief. A cholecystectomy and appendectomy had been performed elsewhere four years before.

The general physical examination including Wassermann test and roentgenograms of the urinary tract and colon was negative. Urinalysis showed only occasional pus cells, and the phenolsulphonephthalein return in two hours was 55 per cent. Cystoscopic examination revealed a normal bladder with apparently clear urine from both kidneys. A catheter was introduced into both ureters to a normal length and the catheterized specimens were normal. On differential functional test the dye made its appearance in three minutes from both sides; the return in fifteen minutes was 15 per cent from the right side, 14 per cent from the left side, and 3 per cent from the bladder. A pyelogram of the left kidney showed definite renal torsion and moderate dilatation of the pelvis and calyces. A diagnosis was made of small hydronephrosis with renal torsion. At operation a hydronephrosis was found with a capacity of about 60 cc. The kidney was fixed and lay nearly transverse as a result of torsion. It was freed from its bed, placed in a normal position, and decapsulated, the capsule being used to hold it in position.

Case 2 (*A68850*). Mrs. J. F., aged forty-eight years, gave a history of a severe attack of right anterior abdominal pain with nausea and vomiting, occurring two years before she came to the Clinic, and a similar attack three months before, which lasted two days.

The physical examination was negative save for a mass slightly movable in the right hypochondrium. Urinalysis and roentgenograms of the urinary tract were negative, and the renal functional test was normal. Cystoscopic examination revealed torsion of the right renal pelvis. A clinical diagnosis was made of possible renal tumor.

At operation the mass was explored through an anterior incision and was found to be a dystopic right kidney. The kidney was lobulated and the pelvis rotated anteriorly and cephalad so that the ureter was drawn tightly over the surface of the kidney. The hilum of the kidney was directed upward and held there by firm bands of peritoneum. The arterial supply had its origin in the aorta. The bands of peritoneum were loosened, the kidney replaced in a normal position and the peritoneum closed. The gallbladder, which was definitely inflamed, was removed. There was an anomaly of the hepatic artery and portal vein which lay across the common duct. Convalescence was uneventful and the patient left the hospital on the thirteenth day.

CONCLUSIONS

1. Incomplete congenital rotation and acquired torsion of the kidney while of anatomic interest are of no clinical importance *per se*.

2. The anomalous position of the renal pelvis and its relation to the ureter may, in certain cases, permit urinary obstruction by some extrarenal factor.

3. Traumatic hydronephroses without direct injury to the kidney may occur following a fall or blow, which is accompanied by renal torsion and fixation of the upper ureter by adhesions.

4. Renal torsion without evident ptosis, or other known etiologic factors, may occasionally occur with a moderate degree of hydronephrosis.

REFERENCE

(1) Herrick, F. C.: Trauma as a factor in the etiology of hydronephrosis (pyelectasis). Jour. Urol., 1921, vi, 1–17.

HYDRONEPHROSIS[1]

WM. C. QUINBY

Boston, Massachusetts

Received for publication August 10, 1922

Instances in which a hydronephrosis exists associated with an abnormality of the renal blood supply in which an anomalous artery crosses the ureter just at its junction with the pelvis have been recognized for several decades. The prevalent idea today is that such an abnormality is a rare one differing in no marked essential from other varieties of hydronephrosis; but a more careful study of the subject would seem to indicate that cases of this sort are not very infrequent; while examination of the clinical histories makes it evident that they form a class showing a strikingly definite symptomatology. Besides the present day failure to recognize these cases there is frequently further failure to apply the ideal type of treatment when the condition is found at operation. For these reasons a renewed discussion of such hydronephroses is to be desired.

ANATOMICAL CONSIDERATIONS

It is well known that anomalies of the arterial blood supply to the kidney are frequent and various. Though normally a single renal artery enters the renal hilus this may be doubled due to early branching, or there may be a double artery throughout the whole extent from aorta to kidney. Of more interest are those instances in which the vascular supply does not enter the kidney at the hilus only but at either one or both poles. There may or may not be a vessel occupying the normal hilus

[1] From the Urological Clinic of the Peter Bent Brigham Hospital, Boston.

position under these circumstances. When there is a polar vascular supply the artery going to the lower pole is frequently found in close relation to that portion of the renal pelvis which is nearest to the ureter. Here the artery may maintain its normal position anterior to the pelvis or it may run posteriorly, or in some instances in which there are two vessels entering the lower pole of the kidney, they may run on each side of the pelvis.

The central origin of such anomalous vessels has been found to be variously from the aorta itself as an independent branch, or even from the spermatic, ovarian, or iliac arteries. It will of course be readily recognized that such anomalous vascular distribution to the kidney is a persistence in part of the earlier fetal condition normally present in the mesonephros, and that with the final ascent of the kidney to its position in the renal fossa some of the blood vessels which are normally absorbed have failed to become so.

PATHOLOGY

On examination of the conditions present in cases of this type which have not become complicated by any incidental factor such as infection, the outstanding feature is the dilatation of the pelvis of the kidney which is always considerable, varying in our cases from about 200 cc. to a liter in cubic contents. Section of the pelvis shows that its wall has undergone distinct hypertrophy. At the outlet of the pelvis into the ureter there is neither stricture nor valve formation, and the orifice of the ureter is not pulled upward onto the side of the pelvis but is found as a rule in nearly its normal position. Just at the junction of ureter and pelvis is found in very intimate relation to these structures the aberrant vessel above mentioned and this may be accompanied by one or two associated veins, the whole making up a very definite band-like structure. The size of the artery apparently varies considerably from one so small as to be of only very minor significance as a carrier of blood to the kidney, up to a size somewhat larger than the radial, which it is evident carries at least one-half of the total blood

supply. The plexus of sympathetic vasomotor nerves which is normally found entering the renal hilus closely adherent to the artery, is not evident in association with the anomalous vessel to the lower pole except in those instances where there is no vessel at all entering the hilus, when nerves can plainly be seen along the course of both upper and lower polar arteries.

The parenchyma of the kidney is found thinned to a greater or lesser degree according to the extent to which the hydronephrotic process has progressed. It is thrown into bosses representing externally the dilated calyces within. All grades of thinning and flattening of the tubules occur corresponding to a renal function which though but moderatly reduced in the less severe cases, may often represent a transformation of the cortex and medulla into a functionless shell.

Examination of the ureter finds it free from dilatation or other abnormality so soon as it emerges from its immediate relationship with the aberrant vessel.

The following histories are illustrative of this condition.

Case 1. No. 6367. A single man, aged nineteen, entered the hospital March 5, 1917, complaining of attacks of pain in the left side. These began two years before entry, and occurred irregularly about once a month. During six months before entry the pain had become more severe, lasting from two to five days and forcing the patient to stay in bed. It was a dull steady pain in the region of the left costal margin and costovertebral angle, radiating sometimes to the back, and occasionally accompanied by nausea and vomiting. The patient's health had always been excellent otherwise. His physical condition was splendid and he was actively at work in an agricultural college. Repeated examination of the urine by his attending physician had shown no abnormality other than a slight trace of albumen and an occasional leucocyte.

On physical examination there was tenderness in the left costovertebral angle, and on palpation a smooth, tender, very much enlarged left kidney was felt. There was some muscle spasm in the back. Over the left flank were found scars of an old herpes zoster.

The admission specimen of urine was of normal color; acid reaction; specific gravity, 1021; a very slight trace of albumen, and no sugar. A few red blood cells were found in the sediment.

Cystoscopy showed the urethra and bladder to be normal. The urine from the right side was normal; that from the left side was seen by microscope to contain an occasional red and white cell. The output of phenosulphonephthalein in one hour from the right side was normal,

FIG. 1. CASE 1. PYELOGRAM BEFORE OPERATION

while from the left there was only a trace. Injection of thorium solution followed by x-ray showed a marked dilatation of the left kidney pelvis.

On March 6, 1917, the left kidney was explored at operation. After penetrating the perirenal fat which was present in normal amount and

FIG. 2. CASE 1. PYELOGRAM A YEAR AFTER OPERATION

Note the diminished size of the pelvis and the funnel-shaped outlet into the ureter.

consistency, the kidney was exposed and found to shell out readily from its fatty capsule. The organ was of good size, rather longer and narrower than normal. In the region of the pelvis there existed a large, globular tumor possibly 8 cm. in diameter, which occupied the region

normally containing the hilus. On investigating the blood supply of this kidney it was found to come from two separate arteries entering at either pole, there being no arterial vascular supply in the equator of the organ. The lower renal artery crossed directly from a direction of above outwards and downwards, in front of the junction of the ureter with the distended pelvis. Because of the size of the pelvis it was impossible to manipulate the kidney in satisfactory manner so that it was necessary to withdraw its contents by aspiration with the needle; 230 cc. were evacuated. Following this an attempt was made to deliver the kidney onto the surface, but this was impossible on account of the shortness of the arteries. A careful dissection was then made of the uretero-pelvic junction. The lower polar vessel was entirely freed from this region and lifted upwards. On the posterior side of this junction a few strands of fairly firm, fibrous tissue were excised. The large, baggy pelvis was then opened by a long incision on its posterior surface running from the region of the renal hilus down nearly to the ureter. On exploring through this it was found that there was no valve-like condition at the entrance of the ureter, but this opening looked, as seen from the inside, rather puckered. The edges of the incision in the pelvis bled rather freely, undoubtedly due to the release of tension by evacuation of the contents. A plastic suture was done on the uretero-pelvic junction by cutting down for about 2 cm. on both sides, that is, on the side of the ureter as well as on the side of the pelvis. This incision penetrated all walls and was reunited by fine catgut stitches, working from the outside; the incision being sewn together in a direction opposite to that in which it was made after the manner of the Heineke-Mickulicz pyloroplasty. The incision in the body of the pelvis was then closed by interrupted fine catgut sutures. The kidney was replaced high under the ribs and held there by one suture of silk, passing through the organ on its posterior surface just above the midline, being tied above the twelfth rib. This anchored the organ firmly in the position from which it had been freed. The muscles were closed with chromic catgut and the skin with silk, a drain being left in as far as the region of the pelvis over which there had been apposed a small bit of perirenal fat. Examination of the renal parenchyma showed that there was a very considerable amount of good kidney tissue present which it would have been unwise to sacrifice by nephrectomy, unless adequate drainage could not be attained by the procedure just described. The patient's convalescence was uneventful, and he was discharged in good condition thirteen days after operation.

A subsequent examination on August 8, 1918, showed that the renal function was within normal limits from each kidney. A pyelogram showed that the pelvis had not retracted to its normal size, 25 cc. being injected without pain, but its outlet was funnel-shaped and the kidney seemed to have much better drainage than before. Since operation there had been no pain whatever and the patient was in excellent health.

Case 2. No. 10848. An unmarried college student nineteen years of age entered the hospital July 17, 1919, complaining of attacks of pain in the left side of the abdomen. This pain had been present, intermittently, for three and one-half years, and was localized under the ribs and in the dorso-lumbar region. The attacks came on suddenly, were very acute, and lasted several hours. Between attacks the patient had very little pain. Occasionally there was an attack of pain on the right side similar to that felt on the left. In January before his admission the patient had an unusually severe attack of pain, accompanied by vomiting. He had also been subject to attacks of vertigo, not associated with the pain, which were accompanied by slight gastro-intestinal disturbances. The patient attributed the onset of these attacks of pain to a fall which occurred while he was swinging by his finger-tips from an upper stair landing in his home. He fell heavily onto the stairs below, striking his left lower ribs and back. Previous to these attacks of pain, and when they were absent, his health was splendid and he indulged freely in all forms of athletics.

On physical examination there was found spasm on both sides of the abdomen together with pain on pressure in the region of the left kidney. Neither kidney could be palpated.

The admission specimen of urine was of normal color; alkaline in reaction; with a specific gravity of 1014. There was a slight trace of albumen, but no sugar. There were many red blood cells, no casts, and a rare white blood cell. On cystoscopic examination the specimen of urine from the left side contained a few white cells, while that from the right was normal throughout. The phenolsulphonephthalein output from the right side was 25 per cent in fifteen minutes; that from the left side was but a trace.

A pyelogram of the left kidney showed the pelvis and calyces to be enormously dilated. The right kidney showed similar, but less marked changes.

On July 23, 1919, the left kidney was exposed. The renal fossa was found to be filled by a large, tense mass. On further investigation

the kidney proper was seen to be much increased in size, especially in the longitudinal direction, and to lie outside and posterior to a second large, tense, fluctuant swelling which extended from the kidney toward the midline of the body. This was carefully separated from the posterior surface of the peritoneum and found to be a very markedly

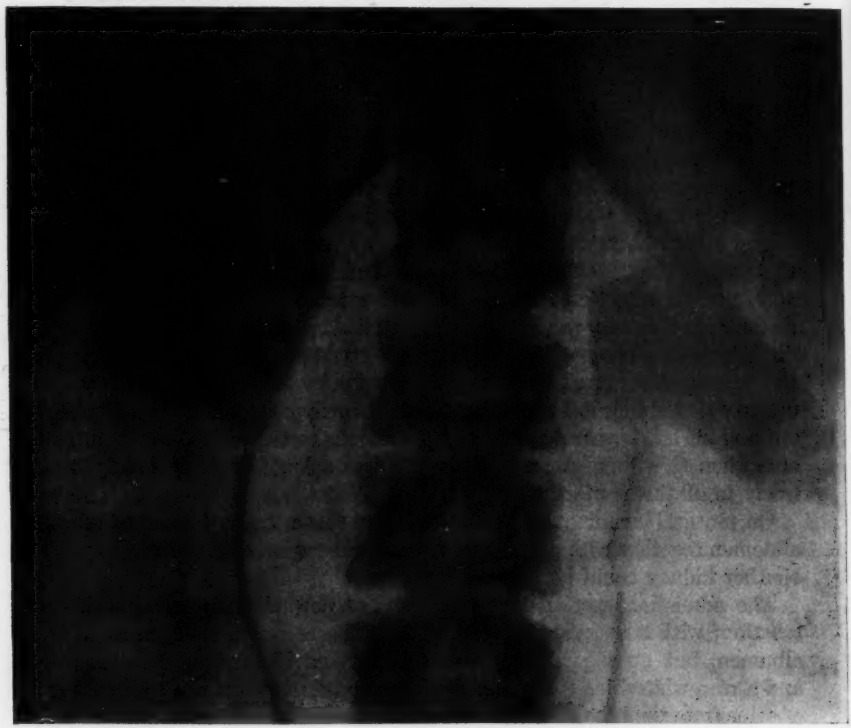


FIG. 3. CASE 2. BILATERAL PYELOGRAM SHOWING HYDRONEPHROSIS ON EACH SIDE

dilated pelvis possible 12 x 14 cm. in diameter lying anterior to the vessels. Investigation of the ureter showed that this was practically of normal size and that the obstruction lay at the junction of the ureter with this enormously dilated pelvis. In order to make further exploration possible the contents of the pelvis were evacuated by a blunt trocar and tube, over 500 cc. of opaque urine being withdrawn. Further

investigation demonstrated clearly that the condition suspected before operation was in fact present, namely, that the kidney had a polar blood supply and that there were two arteries, one reaching the kidney at its upper pole, the other at its lower pole. The upper artery was only palpated; it could not readily be seen on account of its shortness and inability to remove the organ from the renal fossa. The lower artery was accompanied by veins and ran anterior to the ureter intimately connected with it by fibrous tissue. Its size was somewhat larger than that of the radial. At this point the obstruction occurred. The ureter entered the dilated pelvis exactly at its most dependent portion and no carrying up of the ureter on to the side of the pelvis could be demonstrated. In other words, there was no valve formation present. It became evident after complete exploration that no method of freeing the obstruction short of transplantation of the ureter would be successful. The vessels, of course, could not be severed because of fear of destruction of the lower half of the kidney. The ureter was therefore tied just below the lower renal artery and cut across. It was then brought forward and upward and after bevelling its proximal end, was united to the pelvis by interrupted stitches, a longitudinal incision about 1.5 cm. long having previously been made in the pelvis for this purpose. Four retaining sutures of the finest catgut were used through all the coats of both pelvis and ureter and the space between these closed by interrupted stitches of fine silk which did not penetrate the mucosa. After the suturing had been completed the ureter lay in good position being united to the pelvis in an oblique angle, its upper end being a little more dilated than the main trunk of the tube. There seemed to be a little redundancy in length of the ureter and it was attempted to control this by lifting the kidney high and fixing it by suturing over the last rib. The sutures, however, did not hold well, and this attempt was later abandoned, the kidney being decapsulated for a short area over its posterior surface and held up under the ribs by a cigarette wick which was packed in at the lower pole of the organ in the general direction of the suture, but not touching it. The patient made an uneventful recovery and was discharged eleven days after operation, there having been practically no leakage of urine from the wound.

During the three years which have elapsed since operation I have been in frequent communication with the patient and his family. There has been no return of pain and his health is normal.

Case 3. No. 10335. A young woman of twenty-two years entered the hospital on April 21, 1919, complaining of pain in the right side.

This pain, which had commenced ten years before entry, was at first dull and intermittent and well localized in the right lumbar region. The attacks were sometimes accompanied by slight feverishness. Six months before entry the pain became more marked, and two months later darting pains appeared on the left side in a region corresponding

FIG. 4. CASE 3. BILATERAL PYELOGRAM SHOWING EXTREME DESTRUCTION OF THE KIDNEY ON ONE SIDE BY DILATATION WITH NORMAL PELVIS ON THE OTHER SIDE FOR COMPARISON

to that where the dull pain occurred on the right side. Attacks of these pains occurred about twice a week, lasting ten to fifteen minutes. The urine had been cloudy for six months, and between micturition there was occasional burning in the urethra. The urine contained "strings," but there was no difficulty in control; no urgency, inconti-

nence, nocturia, or hematuria. There may have been slight loss in weight.

Physical examination found the abdomen to be tympanitic except in the left lumbar region, where there was slight tenderness. The catheter specimen of bladder urine was clear, amber in color with a moderate number of epithelial cells, and 4 to 8 white blood cells per high power field. Smears from the left kidney and bladder sediment were negative for tuberculosis. Inoculation of a guinea pig demonstrated no signs of tuberculosis. A culture of the bladder urine was sterile.

The x-ray examination showed both kidneys to be indistinct. There were no shadows in any part of the genito-urinary tract that could be interpreted as stones.

The patient was discharged April 29, 1919, and reentered the hospital April 27, 1920. Since discharge she had felt definite discomfort in the region of the right kidney which was distinctly influenced by motion or change of position. For instance, after sleeping on her face she would be awakened after a few hours by this definite pain. She had also experienced a sore sensation over the bladder which was especially uncomfortable when she was sitting down.

Pyelograms taken one day after readmission showed a marked hydronephrosis of the right side, the kidney occupying its normal position. The outline of the right kidney was not shown. With the patient standing there was only the normal change of position of the kidney. The outline of the left kidney was distinctly shown occupying its normal position. The pelvis and calyces were completely injected and were normal.

On May 1, 1920, the right kidney was exposed. On enucleation its cortex was found to consist only of a thin shell of tissue divided into various lobules. Its pelvis showed dilatation similar to that seen in the pyelogram. The ureter was not dilated. On investigating the blood supply of this organ, a branch of the renal artery was found entering the lower pole of the kidney and occluding the ureter by adhesive tissue. This vessel was very nearly the same size as the main renal artery itself. The renal artery entered the hilus of the kidney in a normal fashion. Since there was no value in the remaining kidney tissue a nephrectomy was carried out, vessels and ureter being tied as usual. The wound was closed by a double layer of muscular stitches and silk in the skin.

The patient made a good recovery from operation, and was discharged on May 15, 1920, after an uneventful convalescence. When last heard

from in February, 1922, she was well, and feeling much better than she had felt in the past.

Pathological report. Material: kidney. May 1, 1920.

Gross description. Specimen consists of a shrunken and misshapen kidney which measures 8 cm. in length, 6 cm. in its greatest portion, and 2 cm. in thickness. Externally the pelvis is seen to be markedly dilated. Parenchyma is thin and shrunken. On the external surface it is 1 to 1.5 cm. in width while the pelvis externally is 5 cm. in greatest width. On palpation the organ is found to be cystic. Parenchyma apparently has almost entirely disappeared, being represented by a thick shell of tissue, the pelvis being much dilated and filled with clear urine. At the lower pole of the organ are found the stumps of an artery and vein which, if projected outward, would come in close proximity with the origin of the ureter at the lower pole of the pelvis. There is also an artery and vein of normal size seen in the usual position. On introducing a probe into the cut end of the ureter it is found to pass readily into the pelvis.

Diagnosis. Hydronephrosis.

Microscopic report. Cortex is thinner than normal. Many glomeruli show partial or complete hyalinization and a few show dilatation of subcapsular space. There is increase of interstitial tissue with definite scarring in places. Tubules show varying degrees of change, there being atrophy, hyalinization, edema and occasional dilatation. Practically all tubules contain hyaline or albuminous material.

Diagnosis. Hydronephrosis; polar vascular supply of kidney.

Case 4. No. 15194. A girl of fourteen entered the hospital September 15, 1921, complaining of attacks of dull pain in the left lumbar region. These attacks had been present for one year, and occurred about every ten days, confining the patient to bed for one to three days. They were accompanied by loss of appetite, with vomiting which bore no relation to meals, and a slight decrease in the amount of urine voided. One to two days following an attack the patient noticed an increased output of urine.

The physical examination was negative except for slight tenderness in the left lumbar region, and slight fullness in the costo-vertebral angle. Urine analysis showed: Slight trace of albumen; reaction, acid; specific gravity, 1016; color, normal; sugar, none. The output of phenolsulphonephthalein was 40 per cent. Pyelography showed extreme dilatation of the pelvis of the left kidney. The phthalein out-

put from the right kidney was 15 per cent in ten minutes, and there was only a trace of dye from the left kidney. The microscopic examination of the urine was negative. A diagnosis of hydronephrosis was made, and the patient discharged September 17, with the advice to return soon for operation.

When the patient reentered the hospital on October 5, 1921, the urinalysis showed: Color, yellow; reaction, acid; specific gravity, 1010; albumen, none; sugar, none; a few epithelial cells, and 5 white blood cells per high power field.

On October 10, 1921, a plastic operation was performed on the left kidney. The kidney was exposed in the usual manner and found to be about four times larger than normal, most of the enlargement being due to a dilatation of the pelvis as seen in the x-ray. The surface of the kidney, although lobulated, was otherwise normal and free from unusual adhesions to the surrounding structures. On account of the large size of the pelvis this was emptied by a small knife puncture after which exploration was much more easily carried out. Investigation of the junction of the pelvis with the ureter showed at this point an anomalous condition of the artery, there being two vessels, one running in front, the other behind this portion of the pelvis, intimately related to it and entering blindly the lower pole of the kidney. The blood supply represented by these two vessels, judging by their caliber, was considerable, and it was therefore felt unwise to divide them, if this could be avoided. Nephrectomy also seemed unwise in the presence of so large an amount of good kidney tissue. The condition was therefore treated by section of the ureter transversely just below the pelvis, after which the whole pelvis itself was brought into a position posterior to all the vessels. The segment including the area of vessel-crossing was excised from the pelvis and this wound closed completely by interrupted sutures of fine chromic catgut. The upper end of the ureter was then split downwards on one side by scissors for a distance of about 1 cm., and the expanded end thus obtained was in turn sutured to a new incision in the kidney pelvis made in that position which seemed to be most dependent after the pelvis had been brought into an entirely posterior position. The suturing here was also done with fine catgut.

The patient's convalescence was uneventful there being no leakage of urine from the wound after twenty-four hours. She was discharged in good condition thirteen days after operation.

Pathological report. Material: tissue from ureter. October 10, 1921.

Gross description. Specimen consists of a bell-shaped piece of reddish tissue measuring 1 cm. in length, 1.2 cm. at the base and 5 mm. at the apex. The bell portion of the specimen when everted is seen to be slightly elliptical in shape and has what appears to be mucous membrane on its inner surface. It is slightly injected. Through the central portion can be passed a small probe which emerges at its distal end without difficulty. Externally the specimen is bright red as a result of operative trauma. The appearance of the specimen on cross section is grey and glistening.

Microscopic report. A cross section of the distal end of the specimen shows a stellate-shaped lumen lined with stratified squamous epithelium similar to that of the pelvis of the kidney. The wall is made up of longitudinal and circular muscle bundles and shows no increase of connective tissue or other changes that would suggest a chronic inflammation. A longitudinal section through the proximal portion shows structure quite similar to the above. A few mononuclear cells and polymorphonuclear leucocytes are, however, seen in the submucosa.

Diagnosis. Normal ureter.

Case 5. No. 16202. A young woman of thirty, single, a private secretary by profession, entered the hospital March 5, 1922, complaining of pain in the right upper quadrant. The past history was unimportant except for the onset of this pain when the patient was fourteen. When she was fifteen an operation on the kidney, probably a suspension, was performed. This gave no relief and the patient continued to be troubled by attacks of pain and dull discomfort in the kidney region, not associated, however, with either vomiting or urinary symptoms. Ten years previous to admission the kidney was explored again and at the same time the appendix was removed through a second incision. Following this the patient was very comfortable until one year before admission when she experienced attacks of pain similar to those formerly felt. These attacks recurred at irregular intervals of several weeks, and began with dull discomfort, usually beneath the right costal margin, increasing until there was a marked ache throughout the right upper quadrant. Coincident with the ache there was frequently a feeling of fullness in the right hypochondrium relieved by lying upon it at night. There were no urinary symptoms, but during the attacks the patient could feel a lump in the right upper quadrant which disappeared when the attacks were over.

Physical examination was entirely normal upon admission, but the following day a characteristic attack developed, at which time a well-defined mass could be felt beneath the right costal margin in the anterior

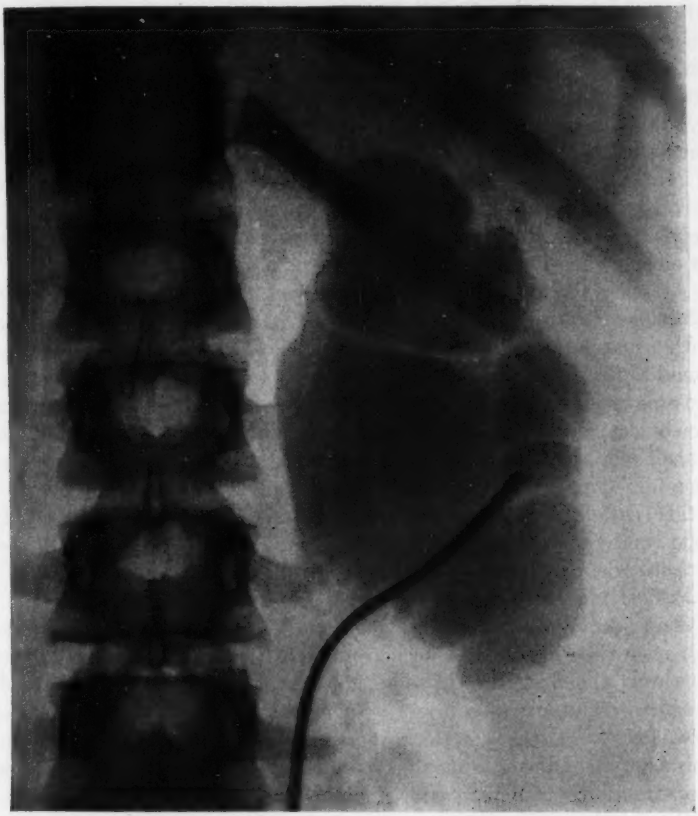


FIG. 5. CASE 5. NOTE THAT THE CATHETER PASSES READILY INTO THE HYDRONEPHROTIC SAC WHICH IS GREATLY DILATED

axillary line. Temperature, pulse, and respirations were normal. The admission specimen of urine was pale in color and cloudy; reaction, acid; specific gravity, 1007; albumen, none; sugar, none. There were

rare white blood cells and red blood corpuscles; no casts. The phenolsulphonephthalein output was 55 per cent in two hours.

At cystoscopy on March 7 the bladder urine was pale and slightly hazy, showing an occasional white blood cell and red blood cell. The urine from the left kidney was pale and clear with an acid reaction, showing 6 to 8 epithelial cells, 4 to 5 white blood cells and 1 to 3 red blood cells. The output of phenolsulphonephthalein from this side was 6 cc. in ten minutes. The urine from the right kidney was reddish-yellow, showing only blood on microscopic examination. There was no function on this side.

X-ray on March 7 showed distinctly the outlines of the kidneys with a catheter in situ on the left. A pyelogram showed no evidence of the pelvis or calices, the shadow of the injected fluid being so faint as not to outline them.

At operation on March 9 there were found very extensive, dense adhesions between the kidney and its surrounding tissues, together with a marked dilatation of the renal pelvis. On freeing this there was found a vessel certainly as large, if not larger, than the radial artery crossing the ureter and entering the kidney at its lower pole. Examination of the parenchyma showed that it was almost entirely converted into a shell of tissue, probably of no functional value. Nephrectomy was therefore done in the usual manner.

The patient had an uneventful convalescence and was discharged in good condition two weeks after operation. She was seen again the end of April when she appeared to be very well.

Pathological report. Material: right kidney. March 9, 1922.

Gross description. Specimen consists of a hydronephrotic right kidney. The capsule has been removed. The pelvis of the kidney measures about 8 cm. in diameter. The kidney substance itself measures about 6 x 3 x 3 cm. An aberrant artery enters the lower pole slightly on the anterior aspect, accompanied by a small vein. This artery, coming anterior to the ureter, has evidently been the source of obstruction. The main arterial supply enters the pelvis of the kidney in the usual manner. The pelvis of the kidney was distended with Kaiserling solution and the whole kidney immersed in the same fluid for preservation as a gross specimen. No tissue was taken for microscopic study.

Diagnosis. Hydronephrosis.

Case 6. No. 16228. A young girl aged fourteen entered the hospital March 9, 1922, complaining of frequent attacks of dull pain in the

left side. The family history and past history were unimportant. The present symptoms began three years before admission and consisted of a dull ache in the left lower back radiating through to the abdomen. The pain was occasionally sharp, but characteristically dull and accompanied by tenderness of the abdomen and left costo-

FIG. 6. CASE 6. A LESSER DEGREE OF DILATATION THAN IN THE PRECEDING CASE

vertebral angle and lumbar region. Lying on the right side aggravated the attack. During the past year the attacks which occurred every week were accompanied by nausea and the vomiting of bile, which recurred at short intervals for twenty-four hours. Seven months before entry the patient was operated upon at another hospital for

questionable "diverticulitis." No diverticulum was found but the appendix was removed. Since then the attacks of pain have occurred every two weeks, lasting three to four days. The vomiting has lasted only for twenty-four hours, and after this the pain has been somewhat relieved. There were never urinary or rectal symptoms. The last attack occurred seven days before admission and lasted four days, with nausea and vomiting for four hours, during the first day. Besides these symptoms the patient suffered from dull frontal headaches for the past two months, not related to meals.

Physical examination was negative except for tenderness and pain on palpation in the left kidney region. Pressure on the twelfth rib caused pain. The admission specimen of urine was pale and cloudy; reaction, acid; specific gravity, 1013; a slight trace of albumen, but no sugar. The hemoglobin was 90 and the white blood count 10,400. Cystoscopy performed on March 13 showed a normal bladder. Both ureters were catheterized and an immediate flow occurred from the right side, but none from the left. Cystoscopy repeated two days later showed a hydronephrosis on the left side. Plain plates of the kidneys with a catheter in situ on the left side did not show the outlines of the kidneys because of slight movement on the part of the patient. There was no evidence of a calculus shadow within either kidney region or along the course of the ureters. A pyelogram showed a hydronephrosis of the left kidney with marked dilatation of the pelvis and blunting of all the calyces.

Operation on March 17 found a large hydronephrosis due to an artery crossing the ureter at its junction with the pelvis and anterior to it. Accompanying this vessel there were two veins of considerable size. Examination of the hilus of the kidney failed to demonstrate any artery entering the organ in this place. The upper pole of the kidney was not exposed but it is to be surmised that there was a similar polar artery in this region also. After the kidney, together with its pelvis, had been made thoroughly movable, the ureter was cut away from the pelvis and the point of its insertion closed by interrupted stitches of fine catgut. A point on the pelvis more dependent and posterior to the vessel was then chosen and the split end of the ureter anastomosed to an incision made in this portion of the kidney pelvis. Suturing was done by interrupted stitches of fine catgut. In this instance the polar supply was evidently double, the lower artery running in front of the pelvis. Its central origin was not investigated. Convalescence was without event, and the patient reported five months later that she was entirely well.

On examination of these histories there are several points which stand out clearly. First as regards the *age*. This condition is definitely one of the young or adolescent. The large majority of cases date the onset of their trouble from sometime within the second decade.

Pain. This is usually definitely localized under the costal margin or in the back in the region of the costo-vertebral angle. It is most apt to appear in attacks varying in frequency, and

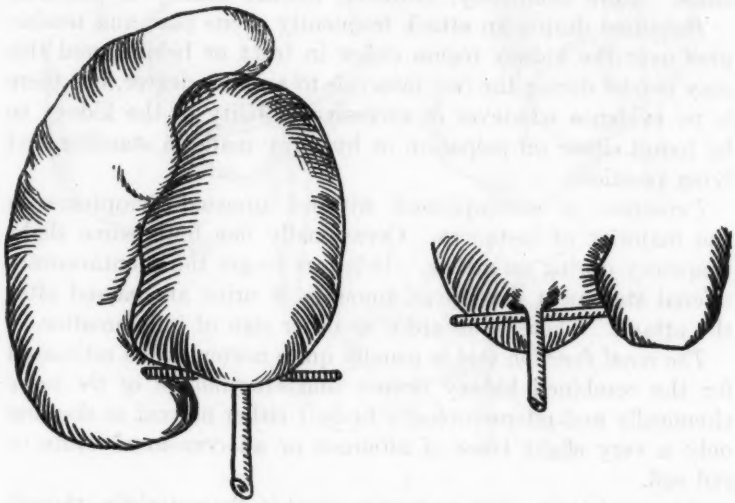


FIG. 7. DIAGRAMMATIC SKETCH OF RELATION OF ABERRANT POLAR ARTERY TO PELVIS AND URETER

with the passage of time, increasing in severity with shortening of the free periods between them. The pain does not radiate much as a rule, except possibly at the height of an attack when it may be referred somewhat along the course of the ureter. In the acute attack nausea and vomiting is common. The acute attack frequently appears to come on rather sharply reaching its maximum in the course of a few hours and then subsiding slowly leaving a heavy aching sensation in the region of the kidney which may persist for several days.

In the intervals between attacks some patients experience a heavy, dragging feeling, sometimes amounting to a real ache on the affected side and it is quite characteristic that certain motions of the body must be avoided, or some especial position must be taken when in bed in order to insure comfortable sleep.

Tumor. In those cases which have progressed to a point where the pelvic distention is great, there may appear a palpable tumor during the acute attack, which goes when the pain subsides. More commonly, however, neither kidney is palpable.

Palpation during an attack frequently elicits pain and tenderness over the kidney region either in front or behind, and this may persist during the free intervals to a minor degree, but there is no evidence whatever of excessive mobility of the kidney to be found either on palpation or by x-ray made in standing and lying positions.

Urination is accomplished without unusual symptoms in the majority of instances. Occasionally one finds some slight frequency during an attack. It is rare to get the spontaneously offered statement that large amounts of urine are passed after the attack. There is no ardor or other sign of inflammation.

The renal function test is usually quite normal when estimated for the combined kidney output and *examination of the urine* chemically and microscopically finds it either normal or showing only a very slight trace of albumen or an occasional white or red cell.

A normal temperature and white count is characteristic, though at the height of an attack there may be slight transient pyrexia.

The general condition of these patients is excellent as a rule, and they are in no way incapacitated except at the time of acute pain. Therefore the *general physical examination* is usually entirely normal except in respect to the points outlined above.

Special examination of the urinary tract is also normal as regards cystoscopic observation of the bladder and ureteral orifices. Catheters of the usual sizes can be passed up either ureter for a normal distance without impediment. Divided renal function gives the first suggestion of the location of the difficulty, one kidney or the other showing definite interference with normal

action. Usually the flow from the hydronephrotic side will be found continuous rather than intermittent, and on investigation by pyelography the actual distension of the pelvis and calyces is made clear.

Treatment. It is obvious that the only form of treatment which will avail is operative. Three types have been employed:

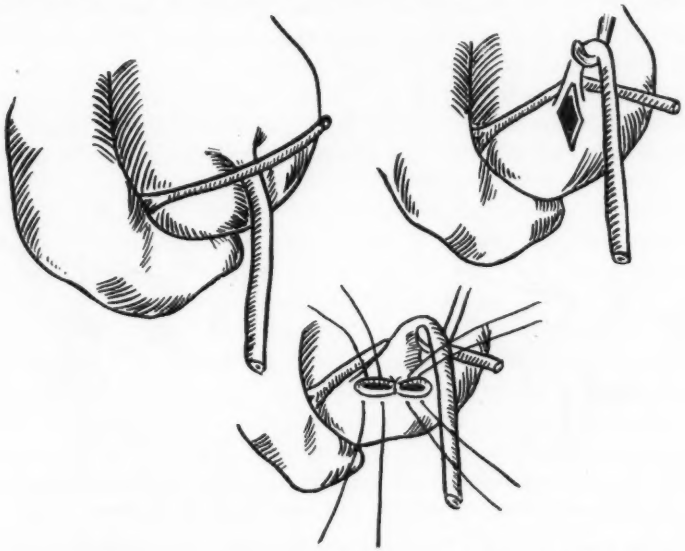


FIG. 8. ONE TYPE OF PLASTIC OPERATION ON THE URETERO-PELVIC JUNCTION
Drawing adapted from Kelly and Burnam, Diseases of Kidneys, Ureters and Bladder, i, 551.

(1) nephrectomy; (2) ligation and section of the aberrant vessel; and (3) plastic operations on the dilated pelvis at its junction with the ureter.

Nephrectomy while definitely curative should always be reserved for those cases in which previous functional examination has shown the kidney to be of no value as a secreting organ. Considering the slowly progressive nature of this ailment it is to be hoped that a proper recognition and earlier diagnosis will make nephrectomy less and less necessary.

Ligation of the vessel has produced cure of the condition in a number of the reported cases. This is only to be justified in those instances in which observation of its size shows that it is insignificant and in which other vessels can be demonstrated to be adequate. The reason for this is that though there is a relatively good system of anastomatic channels within the kidney as viewed by the microscope, clinical experience has shown that necrosis of a portion of the parenchyma follows ligature of all but the smallest of these aberrant vessels.

The most ideal type of operation when the kidney has any functional value is that which does away with the intimate relations between the aberrant artery and the excretory passages.

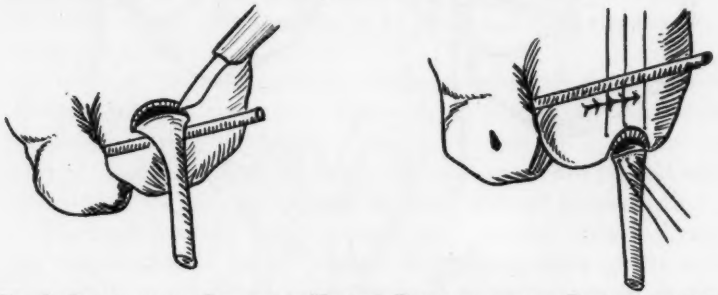


FIG. 9. OPERATION BY SECTION OF URETER, FOLLOWED BY THE REIMPLANTATION INTO A DEPENDENT PORTION OF THE PELVIS AWAY FROM THE ABERRANT VESSEL

In some instances this has been successfully accomplished by a short incision from pelvis to ureter which is then sewn together in the opposite direction after the manner of the Heineke-Mickulicz pyloroplasty. This of course is partly based on the assumption that there is either a stricture or valve formation at the pelvic outlet. Such conditions, though they doubtless occur, judging from the material afforded by our cases would seem to be quite secondary to the formation of the hydronephrosis and not its cause. There was no stricture or valve to be found in any of our cases. A free section of the ureter followed by its re-implantation into the most advantageous portion of the pelvis, away from the vessel, has thus seemed to us the most ideal form of plastic operation, and this has been carried out on three of the cases with brilliant result.

CASES ILLUSTRATING THE CAUSE OF HYDRONEPHROSIS

ARTHUR L. CHUTE

Boston

The careful investigation of renal conditions, which pyelography has permitted us to make in the past few years, has taught us the frequency with which vague abdominal pain, as well as attacks of acute paroxysmal pain, are to be accounted for by a hydronephrosis. Too often the condition has been so far advanced at the time it was recognized that no treatment other than nephrectomy was possible.

It seems to me, as I am sure it does to many others, that the recognition of these cases of hydronephrosis in their incipiency or at least in their early stages offers a very great field for conservative work, perhaps the greatest field that urinary surgery affords today. As this subject is at present receiving a great deal of attention at the hands of many men, it seems to me an especially appropriate time for everyone to present any clinical evidence he may have which bears upon this subject even though that contribution be small; there are many different mechanisms that can produce a hydronephrosis and it is important that one have a comprehensive knowledge of the different possibilities in order that he may apply the correct treatment to the case in hand. It is often difficult to determine especially with a kidney that cannot be completely freed, just what the obstructing mechanism is. This is very difficult if one is not familiar with the different possibilities. In a number of the cases that I shall show, not even the hydronephrosis, to say nothing of the mechanism of the obstruction, was recognized until all thought of doing any conservative operation

had passed and the removal of the kidney was all that was possible. From these same cases, however, the advanced condition of the lesion, in many instances, allows one to see perhaps more clearly than in less marked ones what the mechanism of obstruction was.

The measuring of the amount of urine that a kidney pelvis retains, together with a study of its pyelograms, allows us to recognize a hydronephrosis even in its comparatively early stages. It allows us also to recognize the probable mechanism upon which the condition depends in a certain number of cases. It is a reasonable hope having recognized a hydronephrosis and the mechanism upon which it depends, that we should be able to remedy the trouble in many cases or at least to prevent the steady progression of this condition in a considerable proportion of the remaining cases. The few cases that I wish to report come under four headings: those that are due to aberrant vessels interfering with the ureter at the uretero-pelvic junction; those that are due to a so-called high insertion of the ureter in the kidney pelvis; those that are due to what I believe are inflammatory bands compressing the ureter, and one instance in which the obstruction may have been due to a strictured condition of the ureter itself just below the uretero-pelvic junction.

The cases that are due to aberrant vessels that constrict or compress the ureter make up the type most frequently seen, most easily recognized, and the easiest remedied. I will describe very briefly a few cases of this sort.

Case 1. I saw in 1918 a physician of forty-three whose complaint was hematuria associated with a certain amount of pain in his left loin; investigation showed that his left kidney pelvis held 20 cc. of bloody urine. A pyelogram showed the typical deformity one sees with a vessel that bowstrings the ureter. At operation this deformity was found due to a vein that passed behind the ureter at its junction with the kidney pelvis and looped it up in such a way as to cause obstruction. This vein entered the hilum anteriorly. It was tied and cut. The patient was seen for some little time, a matter of a year or more, following operation and during that time there was no recurrence of his trouble. He has since passed out of my sight.

Case 2. Boy of eighteen seen in March, 1921. He had been poorly for something over a year, suffering from pain in his right side. His appendix had been taken out; following that his rightsided pain had kept up; x-rays had been taken and it was thought that he had an empyema. However, he was tapped and no fluid was obtained. When I saw him he had had three attacks of pain in his right loin in the preceding five weeks. He had a large low kidney. The kidney pelvis

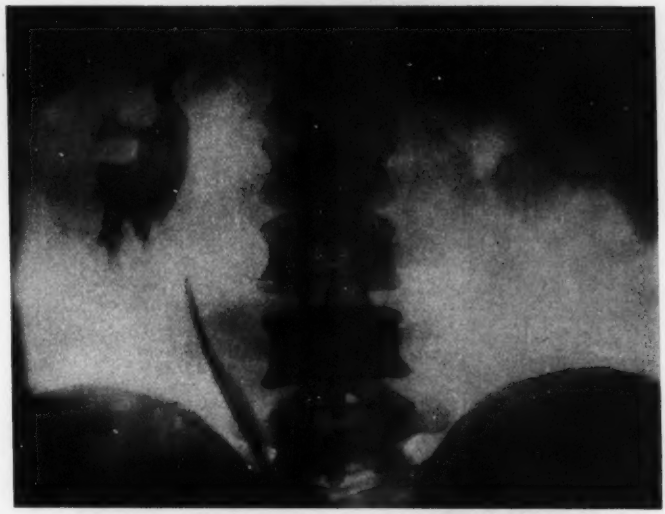


FIG. 1. CASE 1

Extra renal dilatation of kidney pelvis; showing indistinctly in the cut the point of obstruction by extra vessel looping up ureter at its junction with the kidney pelvis.

held 2 ounces and more of fluid. The kidney was cut down upon; the ureter was found to be looped up, practically kinked by a renal vessel that entered the lower anterior part of the hilum. The kidney was removed.

Case 3. A man of twenty-six seen in April, 1921, had had pain in his left side and bleeding for about a month. His left kidney pelvis showed a residual of 10 cc. Pyelograms showed a typical furrow at the uretero-pelvic junction with a bulging forward of the kidney pelvis.

The kidney was cut down upon and an artery and two accompanying veins were found running from the lower part of the hilum, crossing the ureter anteriorly. There were definite adhesions between these vessels

FIG. 2. CASE 2

Drawing of specimen showing an aberrant vessel entering the lowest part of the hilum, and looping up the ureter in such a way as to cause obstruction with dilatation of the pelvis.

and the ureter itself. These vessels were cut and the adhesions separated. This man has not reported for quite a number of months. A short time after leaving the hospital, however, he had reported himself free from pain and bleeding.

Case 4. A man of twenty-three, seen February, 1922. Three years ago he began to pass blood and had done so from time to time since. It was found that his left kidney pelvis would hold 20 cc. without any trouble. There was a typical furrow at the uretero-pelvic junction. The dilatation of the kidney was largely extra renal. A vein was found coming from behind the ureter and entering the hilum on its anterior surface. This was at the point that showed the sulcus in

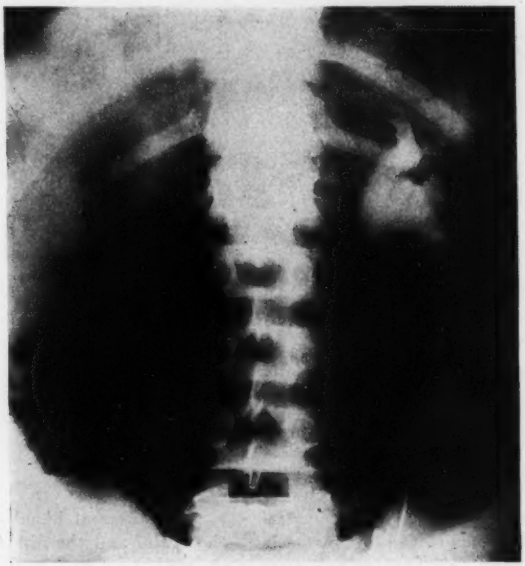


FIG. 3. CASE 3

Showing pyelograms of a hydronephrosis due to obstruction with an abnormal vessel. See line drawing for the condition found at operation; kidney not removed.

the radiograph. This vein was tied and cut. When the man left the hospital a pyelogram was taken under the same conditions as previously and this showed that the pelvis emptied itself at once.

This case is really too recent to demonstrate anything except that after cutting the vessel the pelvis drained itself while before it was not able to do so. There are two points that I would

call attention to in reference to this class of cases: First, the indentation just beneath the enlarged pelvis which is often seen bulging forward a bit above it; second, that cutting the aberrant vessels does not in any way endanger the nutrition of the kidney.

The next mechanism of obstruction that I have encountered most frequently is that in which there is a so-called high inser-

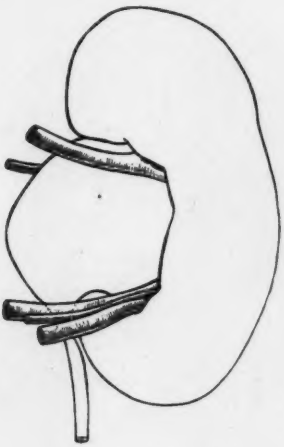


FIG. 4. CASE 3

Line drawing showing diagrammatically the abnormal blood supply, the point of adherence of the lower vessels to the ureter and the dilatation of the pelvis above.

tion of the ureter in the pelvis. This condition is supposed to be the result of a congenital anomaly. It has occurred to me, however, that it is perfectly possible this condition may be the result of a pyelitis which has produced more or less of a cicatricial stenosis of the ureteric orifice and a consequent bulging of the pelvis below; this would give the appearance of a high insertion of the ureter into the pelvis.

Case 5. Man of thirty-three seen in 1917. He had a history of attacks of pain in his left side for five years. His urine was negative,

as is often the case in hydronephrosis. There was a great deal of difficulty in getting ureter catheters into his renal pelvis. When I succeeded in doing this, however, I found there was a "large amount"

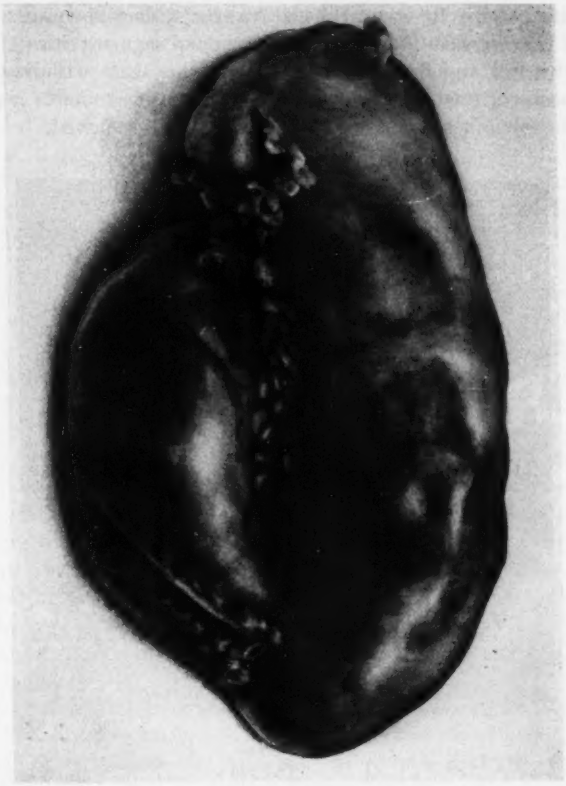


FIG. 5. CASE 5

Drawing of a removed kidney showing rather diagrammatically the raised outlet of the kidney pelvis and the adherence of the ureter to the kidney pelvis.

of residual, the exact amount is not given in my notes. In the pyelogram no thorium entered the pelvis; there was a curious little shadow where there was a very sharp curve or kink in the ureter. The kidney was cut down upon; the ureter was found to have a high insertion in

the pelvis. It likewise was attached to the pelvis for an inch or more. It was thickened and narrow but the thickening was not of the tuberculous type. I opened the ureter in the hope that some plastic could be done. A probe showed that the ureter was perfectly clear below the the point where it was attached to the kidney pelvis. A ureter catheter was passed then through its upper segment into the pelvis and between 6 and 8 ounces of residual urine were withdrawn. The kidney seemed to be destroyed to such an extent as to make it perfectly useless to attempt any plastic. Therefore, it was removed.

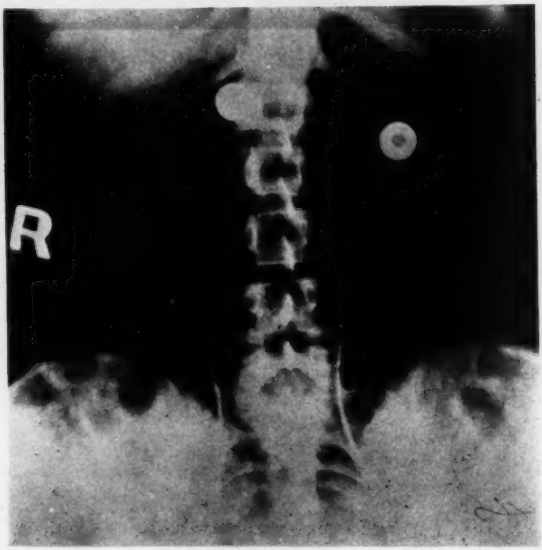


FIG. 6. CASE 7
Showing a very high implantation of the ureter in the kidney pelvis

Case 6. A man of thirty-seven seen in 1921 gave the story of having had more or less frequency and pain. His pain was referred to his left side. X-rays had been negative. A ureter catheter was passed up the left ureter and a large amount of fluid was removed by aspiration. This was another case with a high insertion of the ureter. The process had advanced beyond the point where it seemed to me that any conservative operation would be of use and the kidney was, therefore, removed.

Case 7. A similar case was seen March, 1922. This woman had had pain in her right side for a number of years. She had had various pelvic and abdominal operations carried out. A ureter catheter passed to her right side showed a residual of more than an ounce of urine. Radiographs were taken with 20 cc. of thorium. There was great dilatation of the kidney pelvis and the ureter could be seen curving over this dilated pelvis as it went up to enter the pelvis at a high level. Here as in the preceding cases of this sort a nephrectomy was carried out.

Case 8. Another case of a different kind was that of a woman, forty-three years old, whom I saw in 1912. (I have no slide of this.) She had the history of attacks of pain in her right side, extending back for between twenty-five and thirty years. These attacks were attended with vomiting. It had been supposed that she had gall-stones. The month before I saw her she had had an attack of haematuria. Her urine was, however, normal; when I saw her though her right kidney was found to contain a residual of $2\frac{1}{2}$ ounces. The insertion of the ureter was a little high in the pelvis but the obstruction, so far as I could determine, seemed to be a narrowing of the ureter just below the pelvis. An operation of the Heineke-Mikulicz type was carried out. It did not prove sufficient and a month afterwards I removed the kidney, which was mildly infected. It seemed to me one reason for my failure was that I did not adequately drain the kidney after doing the plastic. I think it is possible that had I established drainage of the pelvis through a tube carried out through the cortex the result might have been different. On the other hand it may have been that the obstruction was due to the high insertion of the ureter rather than to a stenosis.

Case 9. Another patient, a woman of thirty-two, seen in February, 1921, had had a pain in her right side, more or less of the paroxysmal type, for the preceding thirteen or fourteen years. She had had some operations done without relief to these attacks of pain. A pyelogram showed a considerable residual in her right side and a ureter which was held snugly to the pelvis. As the condition was entirely beyond anything in the way of conservative surgery, the kidney was removed. It was found that a fascial band from the pelvis and upper pole of the kidney held the ureter tightly against the lower part of the pelvis. I do not ever remember seeing this type of obstruction mentioned before.

Case 10. A man of twenty-three was seen in the autumn of 1921. He had had a long history of hematuria and urinary discomfort. It was evident that he had a tuberculous kidney on his left, pretty well destroyed. Investigation of his right side showed a hydronephrosis and from this we did not at first get tubercle bacilli. Investigation of his kidney

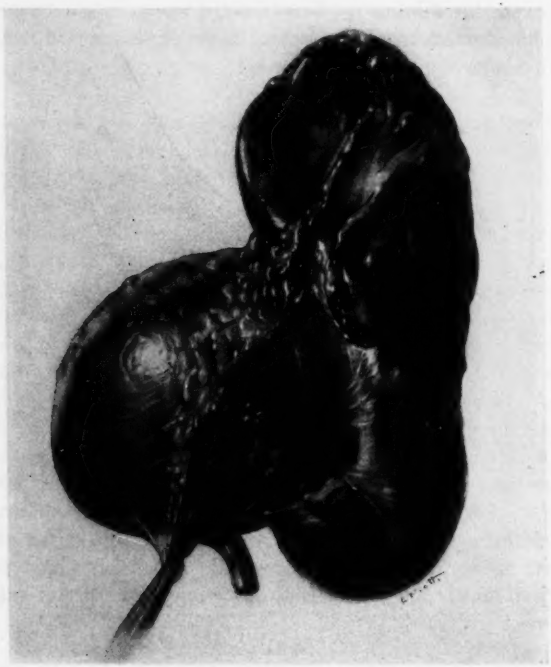


FIG. 7. CASE 9

Drawing of a specimen showing an approximation of the ureter and the kidney pelvis by what was apparently a fascial band coming down from above.

showed a considerable enlargement of the pelvis, mostly extra renal, with a looping of the ureter just below the pelvis that seemed to me to be the result of a cicatricial band behind it. The closed end of this ureteral loop bulged toward the median line. This cicatricial band was cut but the loop did not straighten out as easily as I had hoped. An incision was made in the pelvis and also in the cortex of the kidney;

a large sized ureter catheter was introduced through the cortex and was carried down the ureter for some distance. The man did not get well but died some six weeks following operation. The operation, which was undertaken in the hope that I might conserve for a somewhat longer time his renal tissue was, I believe, ill-advised. I report it simply

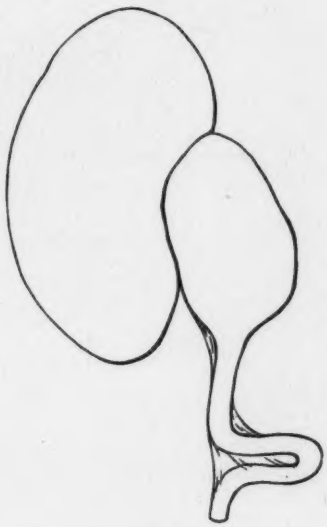


FIG. 8. CASE 10

Diagrammatic drawing showing extra renal dilatation of kidney pelvis, the adhesions producing a fixed kink in the ureter.

as showing an unusual type of hydronephrosis due to obstruction by a cicatricial band behind the ureter.

These cases are presented as showing some conditions both congenital and acquired that have offered enough obstruction to the emptying of the kidney pelvis to have produced hydronephrosis.

SOME CASES OF HYDRONEPHROSIS

R. F. O'NEIL

Boston, Massachusetts

Received for publication August 10, 1922

The 3 following cases recently seen by the writer are of interest because of the extensive renal pathology which was found. They belong to the group of cases presenting pain in the upper quadrant of the abdomen without any so-called urinary symptoms, or any gross abnormality in the urine. These cases generally pass through many hands and are often the objects of surgical assault on various unoffending organs without relief, the kidney remaining unsuspected because of the absence of any disturbance in the urinary function or any change in the urine, combined with the negative physical examination. This is rather remarkabe because they present a typical history of renal colic, very suggestive of calculus and only to be differentiated from it by means of the x-ray and the injection of the urinary tract with some opaque solution. By means of pyelography and ureterography a renal lesion and its underlying cause are readily differentiated from one outside the urinary tract and with the constantly increasing use of these methods the cause of upper quadrant pain should be determined with greater frequency and accuracy. The case histories are briefly as follows.

It will be noticed that in one case a diagnosis had been made of left-sided appendicitis. Operation without relief. In another gall-stones. In the third, no diagnosis has been made with the exception of possible lead poisoning, but the patient had been advised to have the genito-urinary tract studied. The pain in all these cases was of the same type, severe, paroxysmal and

at times associated with nausea. In 2 cases it was local in the loin, and in the third it was, first in the loin, and later referred to the groin. In none of them was there any variation in the urinary function. In 2 cases the urine was absolutely normal. In the third there was the slightest trace of albumin, a rare red blood cell and an occasional hyaline cast.

Case 1. R. Twenty-three years old, married, clerk.

Complaint. Pain in the left loin. Numerous attacks during the last six years. The more recent attacks having been associated with nausea and requiring the injection of morphia. They last a varying length of time and leave a soreness in the loin after they have passed off. The last attack from which he has just recovered was the most severe he has had, lasting four days. There have never been any urinary symptoms. Seven months ago an operation for appendicitis was performed. According to the patient's statement, the surgeon told him he had left-sided appendicitis. No relief since the operation. In fact, the attacks have been more frequent and more severe.

Examination. Well developed and nourished young man. Abdomen, negative except for right rectus scar from previous operation. No masses, no tenderness. Chest, genitals and extremities nôrmal. Urine: catheter specimen; clear; no shreds; normal color; acid; specific gravity 1.022; no sugar; albumin slightest possible trace (heat test); sediment; rare red blood cell; rare hyaline cast.

Cystoscopy. Easily done, bladder and ureteric orifices normal. Left side catheterized without obstruction to the kidney pelvis. Rapid, steady flow of clear urine 120 cc. before flow became interrupted. Blue colored solution injected into the renal pelvis, did not reappear in the bladder. Analysis of the urine from the left kidney: clear; specific gravity 1.018; albumin slightest possible trace; occasional red blood cell; occasional hyaline cast. Culture showed no growth. Sent to x-ray room, 50 cc. (plus) sodium bromide solution 25 per cent injected through the catheter without symptoms. Pyelogram and x-ray report: Plates show no evidence of stone in any part of urinary tract. Outline of the right kidney visible. Normal in shape, size and position. Left kidney not made out. Radiograph catheter enters the pelvis of the kidney in an abnormal position. The shadow of the kidney pelvis after injection is distinctly abnormal. It is much increased in size. The calyces are markedly dilated, but the cuppings are not entirely destroyed. On withdrawing the catheter and injecting the ureter,

a definite kink is visible close to the junction of the ureter with the kidney pelvis.

Diagnosis. Hydronephrosis due to kinked ureter.

FIG. 1. CASE 1. LARGE LEFT HYDRONEPHROSIS DUE TO KINKED URETER

In this case operation was advised after the estimate of the renal function of each kidney, and depending upon those bindings to consist in nephrectomy or freeing of the ureter and possibly some plastic operation on the renal pelvis.

Case 2. N. E. Forty-two years old, married, foreman.

Complaint. Attacks of pain in the right loin for the last five years. At times there have been from three to six months interval between them. The last attack, ten days ago, was severe and was associated with nausea. The pain does not radiate. The attacks last from several hours to a couple of days, leaving a soreness in the loin after they have passed off. There are no urinary symptoms. Patient has been told that he had gall stones. Of late there have been some chilly sensations and night sweats.

Examination. Well developed and nourished man. Chest, abdomen, genitals, and extremities negative. Urine clear, no albumin, no sugar, no sediment.

Cystoscopy. Normal bladder and ureteric orifices. Right side catheterized without obstruction to the pelvis of the kidney. Rapid, but a seemingly ureteric flow of clear urine, which showed on examination an occasional red blood corpuscle only. A clear efflux from the left ureter. The right kidney pelvis was injected with sodium bromide solution 15 cc. without causing pain. X-ray report: Right kidney very low. Shadow of injected pelvis extends below the crest of the ilium. Pelvis large and apparently distended. Calyces dilated and have lost much of their normal cupping. Injected ureter is extremely tortuous and has a sharp turn near the level of the lower portion of the sacro iliac joint. A second, and much sharper kink just below the entrance of the ureter into the kidney pelvis. In the region of the extreme lower calyx is a small dense shadow overlying the shadow of the ilium which is visible in both the injected and partially injected plates. In the completely injected plates there is a spot of increased density within the injected area which is suggestive of a small stone in the lower calyx.

Operation was advised in this case, to consist of freeing the ureter, with fixation and suspension of the kidney and straightening out of the ureter. The small shadow seen in the lower pole of the kidney may be a calculus, but certainly has no bearing on the case as far as producing symptoms is concerned. The injected ureter is very suggestive of a kink, due to the presence of an abnormal renal vessel.

Case 3. H. M. Thirty-eight years old, married, carpenter. This patient was referred to the hospital from the Out-Patient Department

for an examination of the genito-urinary tract for pain in the left back and loin. As he had worked much as a painter it was thought he might have lead poisoning. No evidence of this, however, was found.

FIG. 2. CASE 2. RIGHT HYDRONEPHROSIS DUE TO KINKED URETER

Right renal pelvis suggestive of abnormal renal vessel. Second kink lower down the ureter.

Complaint. Pain in the left loin, below the ribs for the last fifteen months. Five years previous had a similar attack sufficiently severe to make him stop work. The first attack came on suddenly and was localized in the loin. The later attacks radiated to the groin on that side. At first the attacks came about every five weeks, lasted about

three days and disappeared. At the time of the attacks the side was sore and tender to the touch. Of late they have been coming about once a week. They are not associated with vomiting and there have never been any urinary symptoms. He has lost 15 pounds in weight.

A note at time of entrance states, pain seems to be of renal origin, but strange, without any urinary symptoms. X-ray negative, urine clear and sparkling, No albumin, no sugar, no sediment.

Examination. Rather thin man. Chest, abdomen extremities negative.

Cystoscopy. Bladder normal except for slight chronic cystitis. Right ureter catheterized to pelvis without obstruction. Catheter in left ureter stops about two inches short of the kidney. Normal rapid flow of clear urine from the left. Steady flow of clear urine from the right. Sediments: A few red blood cells only from each kidney. Renal function, 1 cc. phenolsulphonephthalein, appearance time two and one-half minutes from the right kidney, 50 per cent excreted in fifteen minutes. No function from the left. Cultures from the left kidney and bladder sterile. Pyelogram: Right kidney pelvis normal in shape, but considerably larger than usual. In the left kidney areas there are some irregular shadows suggestive of hydronephrosis. There is apparently a kink, or stricture, of the ureter at its upper end which prevents the entrance of the catheter into the renal pelvis.

Deductions. Left hydronephrosis due to kink or stricture of the ureter with probable destruction of the kidney. Total renal function. Appearance time twelve minutes. First hour 15 per cent. Second hour 15 per cent. Operation advised.

February 2, 1922, operation, Dr. R. F. O'Neil. Gas oxygen-ether, anesthesia. Left oblique loin incision. Left kidney was delivered. Found to be enlarged. Looked and felt like a good secreting organ. Renal pelvis was considerably dilated and the ureter was found adherent to the pelvis, definitely kinked, the first portion running upward after its emerging from the renal pelvis, this portion being firmly adherent to the pelvis. The ureter was freed by dissection and straightened and the kidney suspended, the idea of nephrectomy being abandoned because of the normal look and feel of the organ, in spite of the misleading functional finding. Convalescence was uneventful. Diagnosis: Bilateral hydronephrosis. Moderate degree on the right, extensive on the left with obstruction due to kinked ureter.

Pyelogram taken seven weeks after operation shows a markedly dilated kidney pelvis, calyces are normal and show normal cupping, and the ureter apparently coming from the pelvis in a straight line.

Cystoscopy done at this time shows a slightly injected bladder, both sides catheterized easily. Free flow of clear urine from the left kidney; 77 cc. obtained. Renal function, appearance time, right kidney four minutes, 20 per cent excreted in fifteen minutes. Left side appearance six minutes, 15 per cent excreted in fifteen minutes.

FIG. 3. CASE 3. BILATERAL HYDRONEPHROSIS
Kinked ureter on the left

After this second cystoscopy a slight infection of the kidney took place, evidenced by a cloudy urine and some tenderness at the left costa vertebral angle, but no pain. There was slight frequency of micturition. This condition, however, has gradually improved and there have been no attacks of pain in the left loin such as occurred previously to operation.

Cases 1 and 2 of this series were seen at the Consultation Clinic at the Massachusetts General Hospital. In this clinic, patients of moderate means are referred by their physicians for

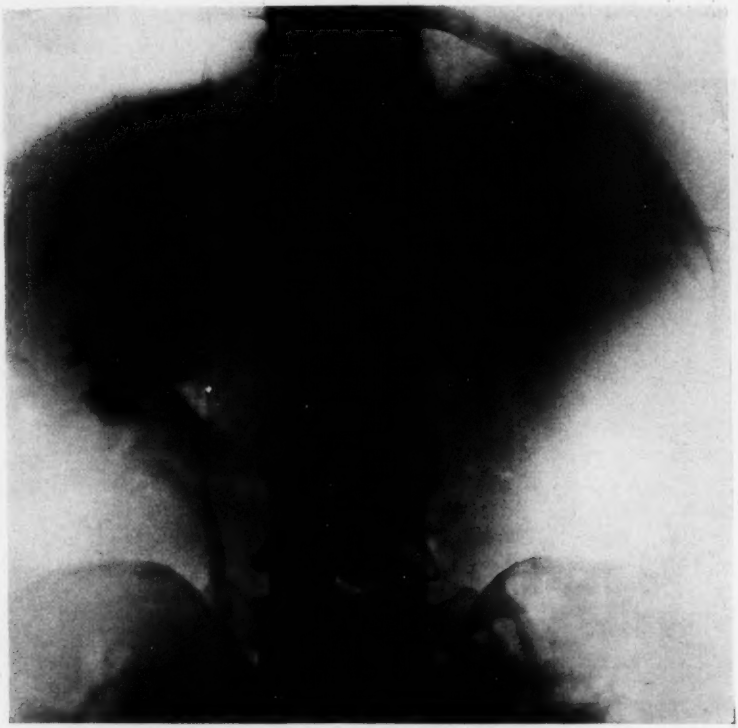


FIG. 4. CASE 3. SHOWING CASE AFTER OPERATION OF FREEING URETER
Left hydronephrosis but ureter apparently is coming from the pelvis of the kidney in a straight line.

diagnosis and are afterwards referred back to them, so that I am unable from personal observation to give the end results in these cases. The following quotation from a letter received from the physician in charge of case 1.

Patient was operated on and a large hydronephrotic kidney removed. The stricture was just at the beginning of the ureter, but owing to the great destruction of the kidney substance and the immense size of the pelvis of the kidney, I did not think there was any use of trying any plastic work on the stricture. The patient made a good recovery, left the hospital in twelve days, and has been completely relieved of his attacks which were continuous up to the time he was operated upon.

Case 2 has not been heard from. These cases are reported for their interest from a diagnostic viewpoint.

TEMPORARY SUPPRESSION OF URINE FOLLOWING DOUBLE PYELOGRAPHY

HENRY H. MORTON

Brooklyn, New York

The following case is reported for the purpose of calling attention to the dangers of doing a pyelography on both kidneys at the same time.

Since pyelography was first introduced into urological practice we have found it a valuable adjunct in kidney diagnosis and have used it as a routine measure in all of our kidney cases in the Long Island College Hospital. We at first used collargol as a solution for getting an opaque shadow of the pelvis of the kidney, but applied it to only one kidney at a time. Later, as reports came in showing the dangers of collargol, we changed our solution and made use of the thorium solution, but a number of months ago replaced that by a solution of bromid of sodium, which is supposed to be absolutely non-irritating and perfectly safe.

Having used bromid of sodium in a great many cases without any signs of irritation or suppression of urine, on one side, a few months ago we began doing pyelography simultaneously on both kidneys with bromid of soda solution, 25 per cent, and had never had any bad results prior to the case which is here reported.

M. L. F., age twenty-nine, married, a strong, vigorous young man, entered Long Island College Hospital January 12, 1922. The history pointed to a calculus in the left kidney or ureter, the patient having had several attacks of renal colic, the last one December 7, 1921. His urine was cloudy, acid, specific gravity 1024, with a large amount of pus and a moderate number of red blood cells. Cystoscopy January 13 showed the bladder to be normal. On the right side a no. 6 catheter passed all the way to the pelvis of the kidney; in the left ureter an obstruction was met about 2 inches from the bladder, but the catheter

finally passed by and entered the pelvis of the kidney. The urine which was withdrawn from the right kidney contained no pus or casts, 4 grains of urea to the ounce, a few streptococci, and the phthalein appeared in four minutes. The urine from the left kidney was cloudy, but contained no pus, casts or bacteria. There were 2 grains of urea

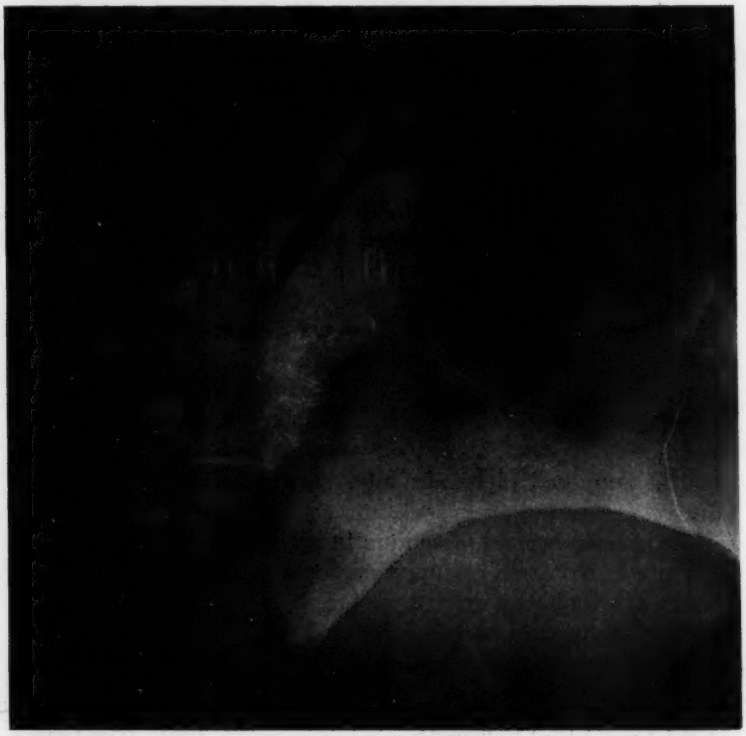


FIG. 1. PYELOGRAM OF RIGHT KIDNEY AFTER INTRODUCTION OF 7 CC. NA BR

to the ounce on this side, and the phthalein appeared in four minutes. A radiograph was taken with the catheters in place and showed no shadow in either kidney, but the shadow of a small calculus was clearly visible in the lower ureter, 1½ inches from the bladder. The pelvis of each kidney was then filled with bromid of soda, 25 per cent solution, by the gravity method and pyelograms were made. The patient did

not complain of pain at the time, but on returning to the ward he complained of severe pain in both kidneys, which lasted throughout the night, and complete suppression of urine followed. For two days following, no urine was secreted, although active treatment was carried

FIG. 2. PYELOGRAM OF LEFT KIDNEY AFTER INTRODUCTION OF 5 CC. NA BR

out by means of hot packs, forced water by mouth, Harris drip and caffein.

At this time we began to consider the advisability of cutting down on the kidneys and splitting the capsules to relieve the tension. During this time the patient looked well, felt well otherwise, had no discomfort, and the temperature, pulse and respirations were normal.

Late in the afternoon of January 15 the patient voided 4½ ounces of urine containing pus and blood microscopically.

FIG. 3. CALCULUS IN LOWER END OF RIGHT URETER

The blood chemistry, after forty-eight hours of suppression, showed:

	mgm. per 100 cc.
Urea nitrogen	75
Urea	160.5
Uric acid	12.5
Creatinin	11

The following day the urinary secretion had increased to 44 ounces, and on the two succeeding days the urinary output was 90 and 102 ounces, respectively, for the twenty-four hours.

On January 18, the patient was voiding freely, felt well, and the blood chemistry was as follows:

Blood chemistry forty-eight hours after secretion was established:

	mgm. per 100 cc.
Urea nitrogen	16.7
Urea	35.7
Uric acid	3
Creatinin	2

We concluded, from the radiographic shadow of the calculus in the lower ureter, that the attacks of renal colic from which the patient had suffered were due to the passage of a small stone through the ureter to its point of lodgment near the bladder, and on leaving the hospital the radiograph showed the small calculus originally seen, still located at the same point. We shall make an attempt later to remove it by means of the operating cystoscope.

This case is instructive in illustrating the danger of attempting a double pyelography at the same time, for if the secretion of one kidney is impaired, the patient has the other kidney with which to carry on elimination until the temporary anuria has subsided.

DISCUSSION

Dr. JOHN R. CAULK, St. Louis: I think that we have heard discussed a most important urological problem and certainly the most perplexing one, and from this program we would interpret that this is a New England disease; but I imagine you are all as busy with it as I am. Such a multitude of causes exists for hydronephrosis that it makes us puzzled as to what to do for it. In the first place the diagnosis is often difficult, as most of the men have brought out in the papers, not particularly difficult for the urologist but for the clinician.

In our series of cases of renal fixation, 40 in all, 30 per cent had a previous appendectomy and 10 per cent had gall bladder operations. Many of our hydronephrosis cases have not complained of Dietl's crises or colic but of pain along the ureter and into the lion; and it is seen how that could be interpreted without sufficient investigation as being due to an appendix.

One other thing we have had in our series—2 patients complaining solely of nausea, and they have run through all the clinics—they have had negative findings, and we were able to reproduce their nausea by filling their renal pelvis under tension. And that brings up one important point in the diagnosis of these conditions. Often we had several things combined with hydronephrosis; and it is hard to discriminate between them all. However we should have no trouble in telling whether a patient has kidney pain if we can reproduce the pain.

Another thing in studying these patients pyelographically it is well to take the pyelograms in two positions, lying and sitting.

Out of this multiplicity of causes of hydronephrosis, I am more than convinced that renal mobility and torsion are the chief factors of causation.

And again, aberrant vessels which may be made more aberrant by changes in the pelvis may be an important cause. I have cut the aberrant vessel a certain number of times and have

not seen disturbances of renal function following the cutting. Possibly there may have been a complete and rapid compensatory hypertrophy on the part of the kidney remaining. However, I would rather cut the vessel if it were in the way than to do a nephrectomy or do a plastic.

I think we have, as Dr. Braasch brought out, more than one factor to correct. That is, we have not only to get that kidney suspended and not oversuspended, but to put it in a proper position so that it will not be under tension, and then we have to correct the torsion. The fat pad, as reported by Bartlett, works in a certain number of cases, but I have seen two cases who have had colic after the operation due to torsion. It has not sufficed to do a padding up from below but to do a fixation of the kidney to obviate its getting later into a position of torsion.

Dr. FRANK HINMAN, San Francisco: The causes of hydronephrosis have been emphasized as aberrant blood vessels or high insertion of the ureter, etc. I wish to state my view to be in accord with what Dr. Caulk has just stated, that it seems to me kidney movability is of more importance in the causation of hydronephrosis than either of these two. You can have aberrant blood vessels which never produce back pressure so long as the kidney is held in position. But let the kidney drop so that these aberrant vessels act as guy ropes and project against the pelvis and you get obstruction produced.

So far as the high insertion is concerned, it seems to me that it is secondary and not primary. You get a slight degree of dilatation with a bagging of the pelvis at its lower portion which, as it grows, draws the insertion of the ureter up so that the high insertion at the late period is secondary and not primary.

One of the most important helps in diagnosis is getting pyelograms taken in the two positions. Often in the prone position you will have a normal looking kidney and ureter, but stand that patient up and abnormalities will be demonstrated which were not before.

The surgery of these aberrant blood vessels and hydronephrotic sacs is uncertain. In 2 cases I have divided the blood vessels

and done a Heineke-Mikulicz on the uretero-pelvic juncture. In two cases I have reimplanted the ureter around the vessels, as Dr. Quinby has reported. In 1 case the upper end of the ureter had a large blood vessel supplying it, and in order to divide the ureter it was necessary to divide the nutrient vessel. It seems to me the blood supply of ureters must be considered if you are going to do plastic operations or reimplantations because the upper end of the ureter gets its blood supply from above downward so that one may have the upper end of the ureter without blood if he completely divides it at its uretero-pelvic juncture. One of my reimplantations was unsuccessful in that a urinary fistula formed and I had later to do a nephrectomy. The other operations were entirely successful and the kidneys preserved.

With respect to another type of hydronephrosis which has not been mentioned here; a type of case in which there are large ureters as well as pelves, hydroureters and hydronephroses. I have seen 6 cases; 1 in a six year old girl, the others in women in which enormous ureters have been present. Dr. Lewis has a case to report with pictures which demonstrates the condition; large, big, tortuous ureters, often as large as small intestines, all the way from the bladder to the kidney, with adjoining walls plastered together. The kidney pelves are enormously dilated and no definite obstruction and the uretero-pelvic juncture is found. There are no demonstrable strictures of the ureter unless at the uretero-vesical sphincter. What has been the etiology of this type of case? Is it congenital? These individuals have had pyuria for years. Renal function has gone down to 5 per cent in two hours or less. All of these cases have been operated upon in two stages, the small opening of the ureter into the bladder has been slit, often in several places to relieve kinks there has been a plastic done on the ureter (showing by drawing on blackboard). Where the ureter curves like this (showing), and its surfaces are plastered together so that the urine will have difficulty in getting around, unless you relieve the obstruction due to these curved ureters, you have not relieved the obstruction to urinary outflow. These kidneys have large

sacs and little parenchyma, and you would hardly expect any recovery after repair procedures, and yet in most of these individuals with both kidneys almost destroyed recovery after bilateral repair was remarkable. So that you can get almost complete recovery if the need for recovery is there, and you can relieve obstruction.

In regard to Dr. Morton's paper on suppression of the urine—I have had 5 interesting cases; 1, a unilateral case of hydronephrosis, who had complete anuria for five days and this time the nitrogen climbed up almost to 200 mgm. in 100 cc. It has been stated that if it gets over 200 mgm. the prognosis is absolutely fatal. That man after this length of time began to secrete urine in small amounts and finally completely recovered his normal function in his other kidney. He later had his hydronephrotic kidney removed and is well today.

In another case which had suppression after pyelography, recovery did not occur. Anuria persisted and his blood nitrogen rose and rose, and we could not get his other kidney to work. We did an autopsy and found that his other kidney was infected, pyelonephritis. Whether that had been stirred up by our cystoscopic examination and pyelography, I do not know. He did not have a bilateral pyelography, but a unilateral. In both of these cases we used thorium nitrate. In our subsequent microscopic examination of the last case we found giant cell infiltration of the kidney apparently due to the thorium. In some cases it seemed as though you could see the thorium in the interstitial tissue. All pyelograms were done by the gravity method, not with the syringe. The solution was not forced into the kidney, and I feel confident that there was not undue pressure to force the thorium back into the kidney. It seems to me the thorium must have produced this marked reflex irritation. We have also had a number of unpleasant experiences after thorium in the way of jaundice. We have had as many as 3 patients in the hospital with jaundice after pyelography with thorium nitrate. I believe it was the irritation and the toxic nature of the thorium which produced the anuria and the toxic symptoms.

Dr. BRANSFORD LEWIS, St. Louis: A case that to me was very remarkable which came under my observation about a year ago is demonstrated in this small x-ray picture which I pass around. A young woman, twenty-three years old, had previously had her right kidney removed by surgical operation (which did not relieve her, evidently) some three or four years before I saw her; and when she came to me she was the picture of emaciation and physical decline. Her urine was loaded with pus and of a specific gravity of 1005, and she had a 5 per cent phthalein output in two hours' time. When we cystoscoped her, we could not get the catheter to go up into the only remaining ureter, but by introducing sodium bromide solution into the bladder we got an excellent x-ray picture (see page 97), showing the sole remaining ureter and kidney to be the subject of dilatation, kinks and tortuosity. The kidney was a nerve pus-sack and almost inert; and it was the *only remaining kidney*. You can see the stricture at the lower end of the ureter which was the cause of this condition. The only thing that could be done was to open up and drain from the kidney. That was done simply to get drainage for the sole remaining kidney; but it was remarkable that she was living with such an amount of pathology and so little renal efficiency. I believe also that this furnishes an illustration of disaster to which a nephrectomy done without preliminary cystoscopy and ureteral catheterization may lead. It is possible that the better of two diseased kidneys was removed.

Dr. FRANCIS R. HAGNER, Washington: I want to say a word with regard to the dangers of pyelography. I believe firmly that in every case where it is necessary to make a diagnosis it is justifiable to do pyelography but I do not think we should do it routinely because it is not without danger. I have had cases in which I have some pyelography and been careful to have no distention, and the patients have been very ill and have had to be operated on at once. It seems to me that the large cases of hydronephrosis are the most dangerous to use pyelography on. In the majority of them you can make a diagnosis without pyelography and we can tell the amount of retention by measuring

DR. BRANSFORD LEWIS' CASE
(See discussion page 96.)

the amount retained in the pelvis. I remember a case of Dr. G. Brown Miller's where he used argyrol. He is a careful man and I am sure he did not use too much force in the injection of the pelvis. It was a woman in rather poor condition, and she died five days after this injection with symptoms closely simulating bichloride of mercury poisoning. At autopsy she had ulceration of the colon and stomach and in the cortical portion of the kidney you could see deposits of argyrol. There is no reason why that same condition might not obtain with the use of these other ingredients for pyelography. So we ought to be careful in its use and only use it when necessary.

Dr. ALEXANDER RANDALL, Philadelphia: I would like to say a word on the technique of pyelography. I have been surprised to hear no mention made during this symposium, and the one of a week ago, of the fluoroscopic technique that we have been in the habit of using at the University of Pennsylvania for the past six years. The method and its advantages are as follows: We first place the ordinary radiographic catheter in the ureter, and place the patient on the fluoroscopic table prepared to inject the opaque fluid from a burette under gravity. The catheter is immediately picked up on the fluoroscopic screen, and one sees, under the eye, the gradual filling of the renal pelvis. Now following this technique, what aid does it give us? First of all, as regards the diagnosis of calculus, ofttimes a difficult question to decide, as to whether the stone is in the cortex or in the upper or lower calyx of the pelvis, and with the ordinary pyelogram, one only sees, after the plate has been developed whether the two shadows are separate or whether the shadow of the calculus has been obscured by the injected fluid. With the fluoroscope technique, one can see the shadow of the stone, and as the pelvis fills, be able to tell the exact relation of the shadow to the renal outline. The same is likewise true in cases of ureteral calculus, and the question as to whether it lies in an ureteral diverticulum or not.

Second, as regards ureteral kinks, again of times missed in the ordinary pyelogram, while at other times possibly exaggerated

or misrepresented from artifacts or filling defects: with the fluoroscope technique, it is possible under the guidance of the eye to move the kidney about; to determine the degree of motility; the direction of motibility; the location of the kink, if any be present; and the actual reproduction of the obstruction. Thirdly, in regard to cases of bifurcated ureter, we have followed out a still further technical move, and that is not to take any plate until we have withdrawn the catheter almost to the bladder orifice of the ureter. This, in 2 cases, has allowed of the observation of the sudden filling of the second renal pelvis from a bifurcated ureter, which would undoubtedly have been missed under any other method. Fourth, this precaution of withdrawing the catheter has done away with the possibility of producing artificially the picture of ureteral stenosis, due to filling defects. Fifth, it has allowed us to place the x-ray plate in the exact position necessary to get a perfect picture. Sixth, it has also been our observation that we are frequently able to obtain all this data without ever having to fill the pelvis to the point of tolerance.

We feel, that following this method, our pre-operative diagnosis has been placed upon a higher plane; that the accuracy of our observation has had a second check placed upon it; and that it has enabled us in a great many instances to obtain the desired end with only one x-ray exposure, because of the certainty of the visual observation prior to recording the same on an x-ray plate. In other words, it has materially shortened our work.

Dr. C. H. Chetwood, New York: I wish to subscribe to the point brought out as to the importance of renal mobility as a causative factor of hydronephrosis and to emphasize the desirability of taking pictures in the upright and recumbent positions.

As has been brought out by Dr. Bugbee and others, the ureteral photographic bougie often gives excellent diagnostic information as a preliminary observation and shows well by comparison any variation of the kidney position.

Dr. H. L. Kretschmer, Chicago: Dr. Hagner's views are my views. I have always made it a rule not to resort to pyelog-

raphy unless it is necessary. I have had two cases of hemolytic icterus following thorium injections which I want to place on record. They were both cases of hydronephrosis in which pyelograms were carefully made and both these patients developed hemolytic jaundice which persisted for several weeks; both patients were very sick. I have not seen hemolytic jaundice follow the use of any other medium. As the icterus followed pyelography, I felt at the time that this procedure was the cause of the icterus.

The danger of using too much force in filling the pelvis has been mentioned. It is well known that if a solution of collargol is used and injected too forcefully, small particles of collargol can be found in tubules, glomeruli and even in the fatty capsule. The significance of this is important. Since it is possible to force the media into the kidney or its fatty capsule, is it not possible to carry bacteria from an infected kidney pelvis into or beyond the kidney, resulting in the production of an acute pyelonophritis? In this way I think we can account for our reactions. Perhaps the occurrence of hemolytic jaundice may be explained in this manner. Therefore, in addition to considering the danger of the media used, we must consider the danger of carrying microörganisms into the kidney.

Dr. Wm. A. Frontz, Baltimore: The rôle played by the several factors which may produce the so-called primary hydronephrosis is frequently difficult to determine. Dr. Geraghty and I in making a study of these cases some years ago were inclined to the opinion that when the dilatation ended abruptly at the junction of the renal pelvis and ureter. An examination of the tissue at this point would reveal in the vast majority of cases a definite fibrosis with contracture. We were able in nine of these cases to obtain tissue for histological examination and in each of them an inflammatory contracture of the ureter-pelvic junction was present.

We felt that where an aberrant vessel lay in such a relation to the uretero-pelvic junction that it *apparently* caused the obstruction. This relationship was more frequently the result of the

altered relations brought about by the increasing size of the pelvis and the descent of the hydronephrotic kidney. The aberrant vessel may in certain cases play a secondary rôle in the obstruction, but the primary factor in most instances will be found to be a contracture of the uretero-pelvic junction.

The water traps described by Dr. Hinman are commonly due to obstruction in the lower end of the ureter and are mere wiggles in the ureter which do no harm.

Dr. J. Bentley Squier, New York: I think that everybody is announcing a note of warning. I might say this in hydronephrosis. Have you ever drained a hydronephrotic kidney through a catheter, emptied it, and noticed how long before there was a recurrence of symptoms? You will find that many of these cases will not have a recurrence of symptoms for months and years. I had a case in 1920 in which I withdrew 18 ounces of urine from such a kidney in a female. She was free from symptoms until December, 1921. At that date 18 ounces were again taken out of that kidney, and she went for three months without symptoms, and I recently removed the kidney. I have seen that in many instances so that when one expects cures and a non-recurrence of hydronephrosis in these plastic cases, I should suggest that one be conservative on the end result until a number of years have gone by because relief of symptoms for a very considerable period often follows simple drainage of the kidney by a ureteral catheter.

Dr. A. J. Crowell, Charlotte, N. C.: There is so much to be said about hydronephrosis that it is impossible to discuss it intelligently in the time alloted, therefore, I will not discuss the paper but simply report an interesting case. This case has been under our care for two and one-half years. The left kidney had been removed on account of a fairly large stone and marked kidney infection. He came to us with a tentative diagnosis of appendicitis and operation with some reservation advised. Investigation showed a very large hydropyonephrosis of the remaining kidney. We withdrew 52 ounces of urine from that

side. This did away with the tumor and gave us the real diagnosis. This kidney was catheterized daily for three months and the pelvis lavaged with antiseptic solutions with the view of controling the infection and putting the pelvis at rest. This has reduced the pelvic retention from 52 to 10 ounces. The ureter is still catheterized twice weekly. If any of you have suggestions to better the care of this case, I will appreciate them very much.

A case of hydroureter with hydronephrosis now under our care is very interesting indeed to us. It is in a girl eighteen years of age in which there is no indication of central nervous system lesions or syphilis. Blood Wassermann and spinal fluid were both negative. She has from 12 to 18 ounces of residual urine with double hydroureter from bladder wall to kidney pelvis as well as double hydronephrosis of moderate degree. She was in a sanatorium for treatment for tuberculosis for three months a few months ago but has no active symptoms at present. I cannot understand why she should have this residual urine. The hydroureter and hydronephrosis, of course, is due to back pressure from the chronic bladder retention.

Dr. Wm. F. Braasch, Rochester, Minn.: Dr. Hagner's point is well taken, that occasionally we can make a positive diagnosis of hydronephrosis without a pyelogram. When it is apparent from cystoscopic data that there is a large amount of urine retained in the renal pelvis nothing can be gained by pyelography. It is often difficult, however, to determine the presence of residual urine in the pelvis and to identify the character of ureteral obstruction without urography, so that the routine employment in doubtful cases is indicated. The pyelograms shown on the screen demonstrated hydronephrosis of the smaller type, a large number of which would have been missed unless pyelography had been done. It is always advisable to drain out the medium carefully after the pyelogram is made, and to irrigate the kidney thoroughly with boric acid solution, for thorium, iodide and bromide all cause some irritation unless they are carefully washed out.

We never employ bilateral pyelography. There is no logical reason for making pyelograms of both kidneys simultaneously, and the possibility of causing serious trouble in both kidneys is always to be considered. The last time that we made a bilateral pyelogram was three years ago. The patient had polycystic kidneys which were not infected on clinical examination. The injected medium was partially retained in the calyces, as often occurs with polycystic kidney, and the man died with bilateral septic kidneys.

The hypothesis that hydronephrosis may be caused by an aberrant blood vessel was first advanced by Israel. In 1907 we reported a series of cases of hydronephrosis, among which a considerable number were shown at operation to be caused by the pressure of aberrant blood vessels. It it undoubtedly true that aberrant vessels may be present incidentally and are not factors in causing ureteral obstruction, but that they often become a factor is shown by the fact that the blood vessel may be severed and the obstruction relieved. Occasionally bands of tissue are found constricting the ureter which, on microscopic examination, are found to be largely composed of atrophied blood vessels. Occasionally the blood vessel is found to have caused actual stricture of the ureter so that the mere removal of the vessel does not restore the lumen of the ureter. There is a wide variation in the frequency of occurrence of anomalous blood vessels with hydronephrosis. I am under the impression that if the operator looks for them carefully and persistently it can be demonstrated that they are etiologic factors in a high percentage of cases.

Dr. WILLIAM C. QUINBY, Boston: This has been an illuminating discussion. I am interested to note in the papers read subsequent to mine that those cases of hydronephrosis which were associated with an abnormal blood vessel were all within the age period which I have pointed out. In studying these cases I have come to the conclusion that they form a very definite group of hydronephrosis. The process apparently develops gradually over a considerable length of time. Starting from

birth the dilatation of the pelvis gradually increases and reaches a sufficient size to cause symptoms only at some period during the second decade of life. If the cases already reported are studied carefully in regard to their histories I think you will find that this fact comes out clearly.

What the exact mechanism is by which the hydronephrosis is caused in the presence of these abnormal vessels is not by any means clear. Personally I feel that the dilatation is probably due to interference with the normal peristaltic wave which begins in the pelvis and extends from there down the ureter. You remember that in a paper read before this society last year on "The pathology of the ureter" I referred to such conditions as these. In these cases there is no actual obstruction to the ureter; there is no stricture; there is no valve. Something, however, interferes with the normal progress of the peristaltic wave from the pelvis to the ureter, and according as this obstruction is greater or less the hypertrophy and dilatation of the pelvis above it is consequently larger or smaller. Such interference with the peristaltic wave can easily be caused by laying on the ureter a small crystal of barium chloride which will interfere for a long time with the downward propagation of the wave. Concerning the general physiology of peristalsis you will remember that the peristaltic wave is at present believed to be the result of metabolic processes starting in an area of higher metabolic rates and propagated toward a region of lower rate. Mere interference with these metabolic processes may be an extensive factor in these cases, but it is probable that the last word has not yet been said on the subject.

I have investigated our patients concerning possible renal mobility by making x-ray examinations of the patient in the upright and prone positions. No abnormal mobility of the kidney has been found, however. True, it is not possible to say that there was no abnormal mobility of the kidney before the dilatation became marked, but I would call to your attention the fact that it is not common to find any very marked degree of movable kidney in children.

Dr. Caulk suggested that abnormal mobility of the kidney might possibly be the reason for the vessel becoming aberrant. I hardly think he will continue with this idea on further reflection in view of the fact that in many instances the abnormal vessels in these cases are not only branches of the renal artery itself, but are frequently found to come from another portion of the aorta or even from the iliac artery. One cannot create a congenital anomaly by the assumption of excessive renal mobility.

Concerning the warning of Dr. Hinman regarding the blood supply at the bladder end of the ureter, I have seen the vessels which he refers to and have found that they can be stripped off of the ureter without tearing them, and that the anastomosis can be made without entirely destroying their integrity.

The question of megaloureter is an entirely separate subject. These large, tortuous ureters are analogous to the tortuous arteries, such as the brachial, in severe grades of loss of elasticity of the arterial wall such as this caused by sclerosis. Here also in the ureter such conditions in the majority of cases are an expression of loss of elasticity by the ureteral wall which causes it to enlarge in circumference and also to become appreciably elongated. The elongation is compensated for by the tube being thrown into S-shaped curves. Such conditions of the ureter are due in the main to two factors: either obstruction below the dilatation, or infection of the ureteral wall itself without obstruction.

Regarding the subject of pyelography it has always been our custom to empty out the pyelographic medium immediately after the plate has been made, regardless of the amount of fluid used. It would, of course, be immediately emptied from these large, dilated pelves.

Dr. Arthur L. Chute, Boston: It seems to me that the diversity of opinion expressed illustrates that our knowledge has not crystallized on these subjects and that we must bring all our facts together and sort them out before we can arrive at anything definite.

SPHINCTEROTOMY PER URETHRAM

A SIMPLE AND SAFE PROCEDURE FOR THE CURE OF CONTRACTURE OF THE VESICAL ORIFICE

J. T. GERAGHTY

From the J. B. Brady Urological Institute, The Johns Hopkins Hospital, Baltimore

Contracture of the vesical orifice as a fairly frequent cause of urinary obstruction is now well recognized. This condition was described in the earlier French literature as "prostatism sans prostate" and in more recent years has been referred to as prostatic median bar obstruction. These terms are intended to refer to a condition which is the result of an inflammatory process and not to obstructions resulting from prostatic adenomas. A pathological study of the lesion now commonly described as "median bar" or "prostatism sans prostate" shows it to be a fibrosis of varying depth involving the vesical orifice particularly in its posterior portion. Microscopic examination of tissue from these cases shows a fibrous infiltration which practically always involves the muscle fibers of the internal sphincter. This inflammatory infiltration diminishes sphincteric relaxation and results in a narrowing of the vesical outlet during the act of urination. This narrowing of the orifice rarely approaches the diminished calibre of strictures found in other portions of the urethra and rarely, if ever, offers obstruction to the passage of fair sized instruments.

In a considerable series of these cases the bladder has been opened suprapubically and the vesical orifice very carefully examined. In every case a narrowing of the orifice has been present and in no instance was a bar formation found to explain the obstruction (Randall). It was found, moreover, in every case that simple division of the internal sphincter in the midline posteriorly resulted in an immediate relaxation of the orifice with complete and permanent relief of obstruction.

If one excludes the suprapubic approach there are three methods employed at the present time for the correction of contracture of the vesical orifice—the modified Bottini operation of Chetwood, the Young "punch," and the cautery "punch" recently suggested by Caulk. All of these procedures while accomplishing a satisfactory end result are not infrequently followed by prolonged sloughing and serious hemorrhage.

The results following mere division of the sphincter were so brilliant that the possibility of carrying out this procedure in a safe and simple manner per urethram was suggested.

The instrument employed for dividing the sphincter is shown in the accompanying figure. It consists of a wedge shaped con-

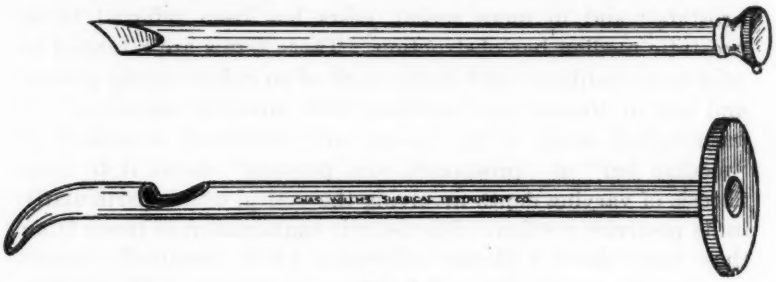


FIG. 1

cave knife which accurately fits a F-28 endoscopic tube similar to the outer sheath of the Young punch.

The technique of the operation is as follows: The patient is prepared as for cystoscopy. The anterior and posterior urethra are anesthetized with a 4 per cent Procaine solution and the bladder filled with 200 cc. of water if possible. The sheath with its obturator is passed after which the latter is withdrawn. After the removal of the obturator the sheath is withdrawn until fluid ceases to escape which indicates that the fenestra has engaged the vesical orifice. In rare instances where the trigone is markedly hypertrophied the ligamentum interuretericum may engage the fenestra. This may be readily recognized by rotating the instrument 90° when water will begin to escape unless the fenestra lies at the level of the orifice. The vesical orifice now

being engaged in the fenestra the knife is introduced and the fibrotic ring divided. In cases in which it is desirable to incise deeply, especially when the fibrosis is unusually thick, a forked spear lifts the fibrous ring into the fenestra. While the spear mobilizes the tissue to be incised the knife is then passed and a deeper cut obtained. This procedure will only occasionally be necessary.

The operation is extremely simple, requiring but a few minutes in its execution. It is further practically painless, causing no more discomfort than the average cystoscopy. It is followed by very slight oozing and in none of the cases operated upon has the urine been any more than blood tinged. It has been unnecessary therefore to introduce a retention catheter, which is nearly always required in the other methods employed.

DISCUSSION

Dr. C. H. CHETWOOD, New York: It is very satisfactory to note that the malady of contracture of the neck of the bladder is so generally recognized that the condition as now understood is denominated under the one title of "contracture." Most of the lesions variously named, referred to by Dr. Geraghty, the elder Keyes, years ago, described and assembled under the present title and I have since tried to emphasize his effort. Many cases have been reported by various writers and treated by different methods but, up to the present time, there are still a certain number that have relapsed or have not been relieved by treatment. If this simple procedure is successful in reducing the number of obstinate cases it will be a welcome addition.

Dr. BRANSFORD LEWIS, St. Louis: I agree with the premises of Dr. Geraghty's remarks, but the deduction that there is not going to be a hemorrhage after incision with the knife I must not agree with. Any knife-cutting is likely to be followed by hemorrhage, more or less severe.

The punch operation of Dr. Young, while efficient, no doubt in certain cases, I am told has been attended by hemorrhages bad enough to necessitate the opening of the bladder. I have worked on a plan to obtain the same object through the use of a platinum blade with the high frequency bi-polar current to burn a deep groove through this contracting ring. That was used without hemorrhage or systemic reaction, but it wasn't sufficiently effective; it did not always burn deeply enough. At the Atlantic City meeting of the American Urological Association last week was shown a new high tension electric apparatus which gave a most remarkable demonstration of a cautery knife which sliced right through muscular tissue, exceeding anything I have ever seen in electric cauterization. I had a conference with the gentleman who demonstrated it and he said he could prepare and furnish

such an apparatus appropriate for use through the cystoscope. I think if you can do this through the cystoscope, under direct observation, it is preferable to the operation done in any other way. I have been successful with Dr. Caulk's punch but I could not get any satisfactory view with that instrument. It is practically a blind operation, the objections to which are obvious. When the new high tension apparatus is completed, I expect this to furnish the most efficient, certain and satisfactory means of removing the contracture at the vesical neck.

Dr. ARTHUR B. CECIL, Los Angeles: The tendency to hemorrhage following the punch operation is well recognized. Similarly the tendency to bleeding following an internal urethrotomy is well known. It would be interesting to know as to whether Dr. Geraghty's procedure is often associated with post-operative bleeding. I have been surprised by the ease with which Caulk's punch divides the vesical neck, and how free from pain patients are who have been operated on by this method. I have not seen any tendency to bleeding following Caulk's procedure, and it would seem to me therefore that the cautery type of division of the vesical neck would be more satisfactory than any type of cutting procedure.

Those of us who have taken care of punch cases I am sure cannot forget our experiences in taking care of hemorrhage. The punch procedure is practically always followed by hemorrhage which is extremely difficult to take care of, and I doubt if those who have not taken care of this bleeding after punch operations realize what this fight has meant. We all know it is quite common to have severe hemorrhage following internal urethrotomy of any type in a vascular field. More recently I have made use of the Caulk punch and I have been amazed to see how easily that cautery divides the vesical neck and how free the patients are from pain and how the patients feel; and so far as seeing is concerned, I have a perfect field, and I feel that there is no doubt that any other structure would be grasped. I have heard of incontinence of urine following the use of the Caulk punch. I have not seen that and doubt if such a thing happens

unless the punch is used badly or more than once because it would have to grasp the internal sphincter and then in withdrawing injure the external sphincter.

Dr. FRANCIS R. HAGNER, Washington: We all know that Dr. Young in reporting his punch operation said there was no hemorrhage. He has such a good corps of assistants, he is never called to the hospital at night. With this operation of Dr. Geraghty's I hope he will never have any hemorrhage, but in all these operations on the vesical neck it has been my experience that you get a certain amount of hemorrhage. In old men I have even gone in and done a suprapubic cystotomy and then done the punch operation and then put the little bag in and drawn it down and they have not bled a drop; and in these cases they do wonderfully well. It is a small opening and they heal promptly, and you are not troubled with hemorrhage, and I think it must be a source of satisfaction to Dr. Chetwood and to Dr. Keyes. I remember years ago when they were talking about contracted bladder neck, and some one said it never occurs. And now I believe the open operation for prostatectomy has cleared up the investigation, and these original co-workers were right in their contention.

Dr. JOHN R. CAULK, St. Louis: I am not claiming magic for the punch, I feel, however, that it has helped me out wonderfully well. I have done 90 cases with this punch and have done them practically all in the office. I have never had to pump out a clot. I have never seen much pain afterwards. All of the individuals said it was so much simpler than the cystoscopic instrumentation. You would think that a burn through the bladder neck would be more painful than the cut, but it is the bleeding and clots which cause the pain.

In these punch operations where there are contractures when you cut through the mid line posteriorly and then try to get another bite laterally, it is almost invariably pulled apart, and the one bite suffices. I have never seen a case of incontinence. At any rate I believe that cutting through the sphincter in these contractures is what gets the results.

If there are recontractures, I am perfectly willing to go back and cut again. There is one warning—and that is to always use an alternating current. Where you have a direct current and transform it you get trouble.

The burning is never right and my only reactions have been in the hospital on the transformed current where the heat distribution has not been proper. The operation is so simple and so effective that I feel that it has a large field of usefulness.

Dr. J. T. GERAGHTY, Baltimore: So far we have had no hemorrhage, although I am sure we will have it later. I am certain that the use of the cautery will be followed sooner or later by hemorrhage when the slough separates. No matter what procedure be employed, hemorrhage will occasionally occur.

I did not know that contracture of the vesical orifice was as frequent as Dr. Caulk's figures indicate. In my experience, it comprises about 10 per cent of bladder obstructions and always has to be considered. The punch and cautery, however, are frequently used for the correction of conditions which are not really obstruction. I refer to those cases of more or less localized inflammation of the trigone near the vesical orifice, which result in vesical irritability and urinary frequency. In these conditions I have used the cautery with good results, not for the purpose of relieving any obstruction, but with the idea of correcting the trigonitis. This instrument which I have presented cannot be used for this condition. It is designed purely for the division of the internal sphincter.

THE OPERATIVE CURE OF INCONTINENCE OF URINE WITH ILLUSTRATIVE CASES

HUGH H. YOUNG

James Buchanan Brady Urological Institute, Baltimore, Maryland

Received for publication July 25, 1922

I wish to bring before you today some cases in which a prominent symptom was urinary incontinence and to discuss the varied problems which they have presented and the operative technique which we have found satisfactory.

GROUP I. POST-OPERATIVE INCONTINENCE

This group includes cases in which the incontinence has come first, as a result of median urethrotomy and prostatectomy, and second, cases of perineal prostatectomy. In these cases there is usually a wide dilatation of both the internal and external sphincters, and the urine flows away from a lack of function of both sphincters. The conditions present are shown in figure 1, in which one sees the membranous urethra widely dilated, owing to the division of the external sphincter posteriorly; post-operative scar tissue in the perineum; and a widely dilated internal sphincter, with absence of the usual elevation of the median portion and with scar tissue replacing the muscle in that region. As seen here the surgical problem is to excise the scar tissue and redundent mucous membrane, and find suitable muscle with which to reproduce a functioning sphincter both at the vesical orifice and in the region of the triangular ligament—external sphincter. The operation which I have now carried out in various cases is generally as follows:

1. Suprapubic cystotomy—Plastic operation upon the internal sphincter

A fairly long median incision is made and the bladder is opened widely so as to get a good exposure of its base. In these cases an examination of the prostatic orifice will usually show a wide-open urethra, and in cases in which the old operation of median prostatotomy has been done, the trigone is sometimes found completely divided, so that one finds a furrow between the divided edges of the trigone and an absence of the usual elevation in the median portion of the prostate. After prostatectomy, the trigone is usually found intact, but the same injury to the sphincter posteriorly is found and the wide-open internal orifice is present. Examination will usually reveal an absence of the usual muscle in the posterior lip or median portion of the prostate and the finger can be introduced deeply into the posterior urethra. The problem is manifestly to excise the mucous membrane, find the muscle and draw it together posteriorly. This is shown very graphically in the accompanying drawings. Figure 2 which was taken from one of our cases shows the internal orifice to be a wide, vertical opening with absence of the usual musculature posteriorly and the anterior part of the trigone. Insert A in the corner shows the free dissection of mucous membrane which was carried out, exposing the muscle of the anterior part of the trigone and also of the two sides of the prostatic orifice. The excision of mucous membrane was carried for a distance down into the urethra so as to leave a considerable mass of muscle on each side of the vesical neck to be brought together with sutures. For this purpose we now use our "boomerang" needle holder (fig. 3) which is well suited for deep suturing. Figures 4 and 5 demonstrate the use of this instrument, and figure 6 shows the condition after placing four stitches so as to draw the muscle and mucous membrane together, leaving only a small and fairly tightly closed urethral orifice above. The suprapubic wound is closed, leaving only a small opening through which the drainage tube emerges, the bladder being approximated with a continuous chromicized catgut and the skin and recti muscle with interrupted stitches of silver wire.

2. Excision of perineal scar tissue and plastic to restore the external sphincter

Figure 7 shows a case in which there was a fairly wide area of post-operative perineal scar. In this case an elliptical incision was made and carried rapidly through the skin and subcutaneous tissues so as to dissect out the scar tissue, as shown in figure 8. In doing this, the muscle on each side was exposed. The excision was carried out until the urethra (in which a no. 18 sound had been previously passed) was reached. Examination then showed that the mucous membrane was redundent, and accordingly an area was excised on each side (fig. 9), reducing the calibre greatly. Additional fibrous tissue was excised on each side until fairly healthy muscle was reached. The closure was effected with the "boomerang" needle holder, as shown in figure 10, the urethral mucous membrane being first brought together so as to invert the edges slightly with a continuous chromicized catgut. The muscle structures on each side were then brought together by a row of deep sutures of catgut, as shown in insert *A*, and the subcutaneous tissues were approximated by a third row of chromicized catgut, as shown in insert *B*. The wound was then packed loosely with gauze and the skin edges were not approximated, as I have found in plastic work upon the perineum, that if the deep structures are brought together in two or three layers, it is unnecessary to bring the skin surfaces together, and if they are thus left open for drainage, there is far less danger of wound infections, stitch abscesses, etc. If the deep wound heals per primam no trouble will be experienced in the closure of the skin. The small sound which is in the urethra is removed before the final closure in the perineum, and no catheter or foreign body is left in the urethra, drainage being entirely supplied by the suprapubic tube which is kept in place for about three weeks when it is removed and the suprapubic wound allowed to heal. I have usually found it advisable to pass a filiform and follower about this time as it was necessary to dilate the urethra in the sutured portions, particularly at the internal orifice which I have usually found over-corrected by the operation and tighter than normal.

Case 1. J. J. M. Age thirty-eight. No. 1502, Brady Urological Institute. Admitted January 30, 1907, with complete incontinence of urine night and day, following perineal urethrotomy, which had been performed one year previously on account of frequent urination and severe pain in the bladder. The operation had not relieved the pain and had produced incontinence. The prostate was not hypertrophied, a slight stricture was present at the bulbomembranous region, but filiforms and followers were easily passed. The bladder held 325 cc.; no residual urine. The tubular urethroscope showed a dilated posterior urethra; verumontanum red and swollen. In the region of the external sphincter there was a long wide slit posteriorly, and there was no central point of closure, but the sides of the urethra were approximated loosely on each side, showing that the sphincter had been divided posteriorly.

Operation was carried out on January 6, 1907, according to the technique previously described.[1] The vesical orifice was found to be gaping, so that the index finger could be easily introduced, and it was evident that the sphincter had been divided posteriorly, and the mucous membrane had healed over the cut. Examination showed what seemed to be the end of the sphincter on each side. These were caught up with tenaculum forceps, the mucous membrane excised posteriorly and laterally, and two catgut sutures placed so as to draw the muscles well together and reproduce a well-closed sphincter. In so doing a small artificial median bar was produced. A large mass of scar tissue was found in the perineum, extending from the cutaneous scar, which was quite broad, to the urethra itself, and from the posterior part of the bulb along the membranous urethra to the anterior portion of the prostatic urethra. Since the median incision through this scar tissue showed no evidence of muscle adjacent to the urethra, a considerable mass was therefore excised on each side, together with some urethral mucous membrane which was very redundant and thick. At no place did the urethra come together as if there were sphincter surrounding it. This dissection was carried well out on each side until healthy looking muscle was reached, it being necessary to go for a distance of about one centimeter. On the left side a definite sphincter-like mass was found. On the right it was not so definite, the fibers appearing longitudinal rather than circular. Healthy looking muscle was also obtained on each side well down toward the prostatic apex. The mucous membrane was drawn together with three sutures of catgut at wide intervals, muscular

[1] H. H. Young, an operation for the cure of incontinence of urine. Surgery, Gyn. and Obstetrics, January, 1919, pp. 84–90.

tissues were then brought together with the necessary sutures of catgut, care being taken, in the region of the membranous urethra, to obtain good muscle for approximation.

Convalescence. The patient, who was addicted to morphia, required 19 to 25 grains daily for almost a week. On the eighteenth day the patient voided a small amount of urine through the urethra. February 9, 1907. Suprapubic tube removed. Patient voiding urine through the urethra without pain, no incontinence, stream small. February 14, 1907: Suprapubic wound closed. Patient voiding through the urethra without pain. February 25, 1907. Evidence of urethral stricture present. Filiform and followers passed, after which patient voided much more freely. May 17, 1907. After dilatation on March 29, patient had slight incontinence for four days. He is now able to retain urine for six hours, voids freely, no pain, good stream, has taken no morphia for four weeks. Is discharged in good condition.

June 25, 1907. Filiform and followers passed on account of slight stricture. Patient retains urine all night without voiding. There is no incontinence. Has taken no morphine.

November 21, 1907. A letter states that the result is almost perfect. He voids urine only once at night, the stream is a little slow in starting, but urination is usually free. He is cured of the drug habit. November 25, 1916. "I have had no sounds passed during the past nine years. I can hold urine four hours, stream good, void urine more frequently at night, am in business and enjoy good health."

Case 2. C. C. Age twenty-five. No. 2708, Brady Urological Institute, was first admitted October 25, 1910, complaining of pain in the perineum. He had gonorrhea about eight years previously, and for one year had had symptoms of prostatic irritation and diminution in sexual power. Examination showed prostatitis and verumontanitis, for which he received local treatment.

Contrary to my advice he had a prostatectomy performed elsewhere, and returned to me, a few months later, complaining of greatly increased burning, and incontinence of urine. He said that an attempt had been made in Chicago to remove the prostate through the perineum, and that he had been very much worse. There was almost continuous incontinence. The cystoscope showed that both the internal and external sphincters had been divided and had failed to close. Local treatment was given but failed to relieve the burning, and urethral dilatation and muscle exercises for the sphincters did not help the incontinence.

The patient then left me again and returned to another surgeon, who operated again through the perineum, and when he came back he not only had incontinence and burning, but also a recto-urethral fistula.

April 9, 1914. Cystoscopic examination showed the internal sphincter had been divided posteriorly. The verumontanum was not seen. The connection with the rectum could not be made out. The internal sphincter was apparently wide open. The external sphincter also failed to close and when the patient was instructed to attempt to close his sphincters, neither internal or external sphincter became completely closed. Rectal examination showed a fistulous opening about 2 cm. within the anal margin.

April 4, 1916, urethroscopy. No. 28-F. urethroscope passed with ease into the bladder. Just in front of the vesical orifice the lateral lobes were a little more rounded than normal. The median portion was depressed, and it was evident that the internal sphincter had been injured posteriorly. The floor of the urethra was irregular, and as the urethroscope was drawn outward, urine continually escaped from the bladder. The utricle and ejaculatory ducts could not be found. The external sphincter was dilated, forming a vertical slit instead of a central figure.

April 4, 1916, cystoscopy. With the posterior cysto-urethroscope the internal sphincter was seen to be dilated. The lateral lobes were a little more rounded than normal, and the median portion much depressed; evidently considerable tissue absent in this region. When the instrument was withdrawn into the posterior urethra, the latter was found to be very irregular, with depressions along the floor, and the verumontanum could not be seen. There was a great deal of scar tissue present. A depression was seen in the anterior part of the posterior urethra, and another small opening just behind the external sphincter, which probably connected with the rectum.

Patient still complained of constant incontinence, escape of urine into the rectum and gas through the urethra, and a severe burning pain.

April 5, 1916. *Operation. Young.* (1) *Suprapubic cystostomy. Plastic operation to repair dilated internal sphincter.* (2) *Perineal excision of scar tissue. Excision of cuff of rectum with rectal fistula. Closure of opening into posterior urethra. Excision of scar tissue posterior to external sphincter. Plastic operation to repair external sphincter.*

Suprapubic operation. The prostatic orifice was found to be widely dilated with loss of tissue posteriorly, and the scar extended backward in the shape of a shallow trough to the posterior limit of the trigone, which had evidently been completely divided.

The muscles of the trigone and median portion of the prostate were evidently widely separated, and the index finger could be inserted with ease into the posterior urethra. The repair sutures produced a distinct median bar which elevated the prostatic orifice considerably and left a very small opening into the posterior urethra. Suprapubic drainage was provided as usual.

Perineal operation. A racquet-shaped incision was used, the posterior portion encircling the anus as in the operation for recto-urethral fistula, which has recently been reported by Dr. Harvey Stone and myself.[2] The scar tissue in the perineum was excised until the urethra was reached, leaving a fairly large opening in the midline which extended back, and included the connection between the rectum and urethra. The sphincter ani was not divided, but was pushed backward while operating upon the urethra, and drawn forward while operating upon the rectum. The rectal cuff was freed on all sides from within the sphincter, which was well preserved, and the fistulous tract having been divided, the cuff was drawn downward until the fistula had been drawn beyond the skin level, where the cuff bearing the fistula was excised. Previous to this the urethra had been closed with five interrupted stitches of fine chromic catgut, and the external sphincter muscles had been drawn together with several stitches of chromic catgut, the anterior mucous membrane was then sutured to the skin as in the Whitehead operation and the perineal wound was partly closed, leaving a small area for drainage.

Convalescence. The patient made an uneventful recovery and was discharged from the hospital in thirty-seven days. He was then able to retain urine for three or four hours, voided freely, and had absolutely no incontinence. No sounds, filiforms or followers were passed on the patient at any time after the operation.

About two weeks later the patient returned and examination showed continued improvement. He was able to retain urine five hours, had no incontinence, voided freely and without difficulty.

May 17, 1917. Patient returns for examination. He reports that he is able to retain urine six hours. Sometimes does not get up at all at night to urinate, occasionally once or twice, voids freely, good stream, no pain. Has had no incontinence since operation, and no evidence of rectal fistula. Still has slight burning pain in the prostatic region, and the urine is cloudy with some pus present. General health is excellent.

October, 1918. Excellent result maintained.

[2] H. H. Young and Harvey B. Stone, The operative treatment of urethro-rectal fistula, presentation of a method of radical cure. Jour. of Urol., June, 1917, i, no. 3.

Case 8. J. W. S. Age fifty-two. No. 10,000, Brady Urological Institute. Admitted October 4, 1921, complaining of incontinence of urine. There was a history of gonorrhea at the age of twenty-seven, followed subsequently by chronic prostatitis and changes in sexual powers, and for twelve years there were symptoms of burning, hestitation and frequency of urination. Two years previously had had a suprapubic operation at which time the internal sphincter and neck of the bladder were widely dilated. As this did not relieve the symptoms, patient had a second operation several months later when an external urethrotomy was performed through the perineum. Following this patient had incontinence of urine and continued to have pain in the urethra and bladder with occasional hematuria.

Examination showed perineal and suprapubic scars. Prostate was only slightly larger than normal and slightly indurated. Seminal vesicles were indurated and adherent. Cystoscopy showed a wide cleft posteriorly between the lateral lobes. Upon drawing the cystoscope out, a deep scar in the floor of the urethra could be seen. Examination of the perineum showed a depressed scar, and it was thought advisable to carry out the radical operation on both internal and external sphincters.

October 10, 1921; *suprapubic cystostomy.* The prostatic orifice was found to be wide open and in the median portion there was a deep furrow which included the anterior part of the trigone and extended down into the posterior urethra. There was considerable scar tissue present. This was excised with the mucous membrane and the muscle tissues were brought together as usual with three chromic catgut sutures which were inserted with the "boomerang" needle holder. The *perineal operation* was carried out as usual. A considerable amount of scar tissue was excised and redundant mucous membrane along the floor of the urethra was removed. Considerable destruction of the muscular structures of the perineum had occurred but it was possible to get fairly good muscle which was drawn together with the "boomerang" needle holder.

Convalesence. The suprapubic tube provided satisfactory drainage for the bladder which was removed during the third week. One month after the operation a small catheter was passed through the urethra and fastened there to facilitate closure of the suprapubic wound. It was removed five days later, when the suprapubic fistula was closed and the patient was voiding normally through the urethra.

November 30, 1921. All wounds closed; patient has perfect urinary control and voids at intervals of four to six hours without pain or discomfort. Urine is still infected. December 3, 1921: Patient dis-

charged voiding at intervals of every six hours with excellent control. Urine still infected.

GROUP II. VESICAL PERINEAL FISTULA WITH INCONTINENCE FOLLOWING FRACTURE OF THE PELVIS

This condition has been met with at the Brady Clinic in three cases, one from the practice of Dr. Colston to whom I am indebted for the privilege of including it. In these cases, following severe accident, the pelvis was badly fractured and the bladder and urethra ruptured with resultant incontinence of urine which was found in all cases to be due to the formation of peri-prostatic vesico-perineal fistulae. In these cases the operation required both suprapubic and perineal attack with excision of the fistulous tract, closure of its internal orifice, closure of the perineal wound, and, in one case, repair of the external sphincter. The procedures carried out have varied in each of these three cases are briefly given and illustrated by the accompanying drawings.

Case 4. W. H. M. Age twenty-two. No. 8592, Brady Urological Institute. Admitted March 18, 1920, complaining of leakage of urine through penis and old perineal fistula. Present illness dates back to 1914 when his right pelvis was crushed in an accident. He was in the hospital for six months during which time he was operated upon four times. The perineal fistula never closed, and in 1918 he was again operated upon, an effort being made to close the fistula, but with no result. Following this operation, he developed incontinence and was unable to hold urine. At present he passes urine through the urethra but has complete incontinence. There is also a slight leakage of urine through perineal fistula. At night there is generally no leakage and patient is able to retain urine for five or six hours while on his back. As soon as he stands or walks, urine begins to escape. His sexual powers have become diminished since accident and erections are very incomplete. General health is excellent. No history of pain.

Examination. General physical examination is negative. Penis is normal in size. There is urine dripping for the meatus. Testes and epididymides are normal.

Rectal. On examination of the perineum, a deep fistulous opening is found in front and to the left of the anal opening. The anal sphincter is of good tone but the anterior wall of the rectum is bound up in scar

tissue which also involves the perineum. The prostate is a little more prominent than normal but smooth. Right lobe is normal in consistence nodular and adherent. Left lobe is slightly indurated, drawn outward considerably and adherent. Both seminal vesicles are enlarged, indurated and adherent externally and to the prostate below. Between the vesicles the tissues are indurated, forming an intervesicular plateau which extends 1 cm. above the base of the prostate.

Urine. Acid, cloudy, specific gravity 1.012, trace of albumen, no sugar, no casts, moderate amount of pus. Infection: colon bacillus.

Phthalein test. Intramusular; Appearance time, 12 minutes; two hours, 70 per cent.

Instrumentation. Sounds up to no. 26-F. are quite readily passed into the bladder, taking a course slightly to the right of the midline when the posterior portion of the bulbous urethra is reached. There is no residual urine present; bladder capacity 230 cc. Urine is quite cloudy. When considerable fluid is introduced into the bladder, none escapes through the perineal fistula.

March 27, 1920, cystoscopy. Cysto-urethroscope passes with ease. There is no residual urine and bladder capacity seems about normal. Cystoscopy shows a fairly normal trigone and normal ureteral orifices. Just in front of and to the right of the trigone and midway between the ureter and the prostatic orifice there is a deep depression which seems to be the intravesical orifice of a fistula. The prostatic orifice is apparently dilated, the posterior margin is less pronounced than usual, and it is possible to draw the cystoscope out of the bladder into the posterior urethra without passing the intervening median elevation which is usually seen. The entire prostatic margin is less sharply defined than normal. The verumontanum is not definitely made out, and to the right of the median line posteriorly there is a peculiar deep depression or hole. A filiform passes from the perineum into the urethra at this point, thus demonstrating the presence of a urethral perineal fistula. In order to study the external sphincter, a tubular urethroscope is introduced, no. 28-F. It is impossible to introduce the instrument into the prostatic urethra owing to the cicatricial ring which is quite visible. The floor shows a linear cleft or depression such as are seen after median perineal urethrotomies in which the external sphincter has been divided. This condition extends well out into the bulbous urethra. The lateral and superior walls of the urethra are quite normal.

Impression. We have here incontinence of urine due to injury and dilatation of both the internal and external sphincters, also a fistula

from the perineum to the prostatic urethra and probably a fistula from the base of the bladder connecting with the other fistula.

Indications. Suprapubic cystostomy; closure of vesical fistulae; repair of internal dilated sphincter; suprapubic drainage; perineal operation to excise the perineal fistulae and repair internal sphincter.

March 29, 1920. *Operation, Young. Gas and ether. Suprapubic cystostomy with excision of two fistulous tracts. Perineal section with excision of fistulous tract connecting with the mid portion of the prostatic urethra and bladder. Excision of perineal scar tissue and repair of external sphincter and triangular ligament. Suprapubic drainage.* The bladder was opened by linear suprapubic incision and an excellent view obtained. Inspection showed two fistulous openings (the ones which had been seen with the cystoscope), about 1 cm. in diameter and to the right of the trigone, about midway between the ureters and prostatic orifice. This easily admitted a large clamp which passed for a considerable distance and communicated with the fistulous tract in the perineum. In front of this and to the right of the prostatic orifice a second fistulous opening was found (which had not been seen with the cystoscope) about 5 mm. in diameter, which readily admitted the probe for a distance of 2.5 cm., apparently pursuing a course anterior to the prostate, whereas the posterior fistula took a course that was retro-prostatic. The operator decided to excise these fistulous tracts and placed the patient in the perineal prostatectomy position upon the Young urological table. A midline incision was then made in the perineum, the posterior end of which encircled the fistula which lay near the anus. The incision was carried through the scar tissue to the urethra and the fistulous tract excised to a point where it communicated with the prostatic urethra. Here it was found that the fistulous tract divided, one passing anteriorly to the right and opening into the bladder to the right of the prostatic orifice. The other travelled posteriorly behind the prostate and opened into the bladder to the right of the trigone. The latter tract was dissected free up to near the bladder, a small prostatic tractor which had been inserted through the fistula into the bladder being of considerable assistance in drawing down the fistulous tract towards the perineum. The tractor was then removed. The operator then turned his attention to the suprapubic wound and passed a clamp through the posterior fistula until it appeared beyond the fistulous tract. Here an assistant inserted into the separated blades of the clamp the lower extremity of the freed fistulous tract, and traction was then made from above inverting the fistulous tract and

drawing it into the bladder where it was excised completely. The tract which travelled anteriorly and opened into the bladder to the right of the prostatic orifice was thoroughly curetted up to the vesical orifice. By means of the Boomerang needle holder four interrupted catgut sutures were placed extravesically through the perineum so as to close completely the posterior fistula. The anterior fistula was closed intravesically after thorough excision of the edges with scissors and curettage, four sutures of chromicized catgut being used. Attention was then directed towards the triangular ligament and external sphincter which was surrounded by an extensive mass of scar tissue. This had to be excised before normal tissue was found on each side. A portion of the mucous membrane was excised so as to reduce the dilated urethra, and after apparently healthy muscle had been secured on each side, the urethra was drawn together with a layer of four interrupted sutures of no. 2 chromic gut and a second layer of sutures approximated the muscular structures around the urethra. The skin was not drawn together but packed superficially. The bladder was then cleaned of clots and an inspection of the vesical orifice showed the sphincter was of good tone. It was therefore decided to do nothing to it, as the incontinence was thought to be explained by the leakage through the fistulous tracts rather than relaxation of the sphincter. The suprapubic wound was closed with a drain at the upper end, and the skin and recti muscle were drawn together with interrupted sutures.

The operation was long and tedious and the patient was slightly shocked at the end; pulse 110.

Convalescence. On returning to the ward, patient was considerably shocked and an infusion of salt solution was given. After this, patient made a satisfactory convalescensce. On the fifth day the suprapubic tube was removed and a Pezzer catheter inserted suprapubically. On the eleventh day suprapubic tube was removed and not replaced. On the fifteenth day urine passed through the penile urethra and on the eighteenth day patient was out of bed. There was no perineal leakage. On the twenty-seventh day patient had good urinary control and there was a very slight suprapubic leakage. Two weeks later the suprapubic fistula healed completely.

June 9, 1920. Patient discharged with suprapubic and perineal wounds completely healed, no fistulae. Patient is able to retain urine for three hours; has a slight leakage on moving around. On voiding, he can stop the outflow of urine voluntarily and start it at will. He is advised to practise his sphincter muscles in order to improve their tone.

June 14, 1922. *Letter.* "Soon after leaving the hospital, I began to lose control of urination (would dribble) while on my feet, while at night I have been able to retain my urine for five or six hours without incontinence. If I am sitting in a comfortable position, I can go sometimes for two hours and can retain urine for twenty minutes after I begin moving around. Then the muscles seem to relax and I lose control. I void urine freely and can stop it while I am lying down. Sometimes I can stop the flow when I am standing but not always. I have had two nocturnal emissions but erections are very imperfect and intercourse has proved impossible. Sexual desire is slightly impaired."

Remark. This patient should be cystoscoped to find out whether one or both of the internal vesical orifices of the fistulae have reopened. The perineal fistula is well closed and the patient seems to have fairly good control of the external sphincter. At cystoscopy it was thought the internal sphincter was dilated but at operation it was thought to be normal and no attempt was made to tighten the prostatic orifice. The question therefore arises, is the failure to get a perfect result in this case due to a dilated internal sphincter or a reopening of the vesical end of one of the two fistulae, the perineal orifice of which has been successfully closed? Patient advised to return for examination.

Case 5. C. J. D. Age forty-two. No. 9234, Brady Urological Institute. Admitted November 18, 1920, complaining of incontinence on urine and pain, suprapubic and perineal fistulae. Three years before the patient was struck by an automobile truck and sustained a fracture of the pelvis with rupture of the urethra and extravasation of urine. He was taken to Boston and operated upon by a surgeon there who found "the ramus of the left side fractured and pushed into the bladder. This fragment was removed by a suprapubic incision, when a rupture of the bladder and of the urethra were discovered. The urethra was torn off at the junction between the membranous urethra and prostate, and the whole anterior surface of the prostate was split open." Patient was badly shocked and it was possible only to pack the suprapubic and perineal wounds. The suprapubic wound healed in about a month, but a perineal fistula remained and the patient had incontinence of urine until about a year later when he had acute retention of urine, and as it was impossible to insert a catheter through the urethra, the surgeon carried out another suprapubic operation for drainage. At the second operation, several small stones and some necrotic bone were removed through the perineum, and a plastic operation was carried out to reestablish the urethra which had been ruptured at the apex of the prostate.

During the ensuing months, patient had repeated perineal abscesses and the suprapubic and perineal sinuses both closed and opened spontaneously several times. Incontinence of urine was present; bladder capacity small. A third operation was carried out several months later, which showed "a deformed pelvis encroaching upon the urethra and bare bone along the left lateral wall of the urethra to which it was closely adherent." Following this operation, patient continued to have incontinence of urine and the perineal fistula did not heal. This was the condition present on entrance. Since accident patient has had no erections.

Examination showed in the midline above the pubis a depressed scar but no fistula. In the perineum there was an extensive scar with a fistula through which urine excaped. With finger in rectum and thumb against perineum, a hard movable body, probably a stone, about 1.5 cm. in length could be felt in the urethra. On rectal examination, prostate was a little broader than normal, slightly irregular, indurated in its upper portion, the induration extending up into the region of the bladder, giving one the impression of a calculus which projects from the bladder into the prostate. X-ray examination showed a shadow about 1½ inches in diameter in the region of the bladder, and also a smaller shadow in the median line beneath the symphysis pubis, probably in the membranous urethra. Conditions present, as subsequently discovered, are shown in figure 11.

November 23, 1920. *Operation, gas and ether anesthesia. Perineal and suprapubic operations to remove calculi from perineum, urethra and bladder. Partial excision and curetment of sinus running from the anterior wall of the bladder into the perineal urethra.* Patient was first placed in the perineal prostatectomy position and an incision about an inch long was made, enlarging the fistula and exposing a stone in the perineal urethra. This stone proved to be about one inch in length and ¾ inch in diameter and was easily removed. It lay in the region of the membranous urethra but projected into the apex of the prostate. The external sphincter was apparently destroyed or widely dilated, and the membranous urethra was very large and surrounded by much cicatricial tissue. Just in front of the stone there was a fistula which extended behind the symphysis pubis and into the bladder, more or less paralleling the prostatic urethra, and it seems probable that urine escaped through this fistula and that the urethra was blocked by the calculi. The finger could be introduced through the prostatic urethra into the bladder where a large calculus was detected. Patient was then placed in the Trendelenburg position and suprapubic cystostomy performed. The bladder was con-

tracted, the anterior wall very thick, and a stone about 2 inches in diameter was removed without difficulty. There was no diverticulum present. The prostatic orifice was slightly dilated but there was "no fibrosis or suggestion of contracture." The internal sphincter seemed to be intact though possibly slightly dilated. On the anterior wall of the bladder, at a point about 1.5 cm. distant from the prostatic orifice, and anterior and external to it on the left side, was an irregular orifice of the fistula (figure 12) which communicated with the urethra in the bulbomembranous urethra as above described. This fistula was exposed by continuing the anterior vesical incision downward; and it was thoroughly cureted and granulations and scar tissue partially excised and packed iodoform gauze. Suprapubic abdominal muscles closed with silver wire.

Convalescence. The perineal and suprapubic fistulae persisted and patient had incontinence. It was found impossible to pass instruments into the bladder owing to obstruction near the apex of the prostate. It was finally necessary to insert a cystoscope through the suprapubic wound and thus to pass a ureteral catheter from the bladder through the prostatic urethra and out the perineum, thus dilating the stricture at the apex of the prostate, after which instruments were passed through the perineum into the bladder, and subsequently also filiforms and followers were passed through the urethra.

April 26, 1921. Patient has almost complete incontinence night and day; is unable to retain urine for more than fifteen minutes. Urine escapes through perineal fistula and only slightly through the penis. Suprapubic wound healed. Sound passes through the urethra into the bladder easily and shows no evidence of stricture.

On May 12, 1921, as the incontinence of urine persisted, I decided to carry out a *radical operation* for its cure. This was done under gas, ether and oxygen anesthesia. Suprapubic cystostomy was first done. Prostatic orifice was found to be slightly dilated, with a tear in the left lateral margin and the musculature in this region less abundant than normal. The trigone was shortened and thickened. About two centimeters distant from the prostatic orifice, on the anterior wall, there was a fistulous opening through which a probe could be passed beneath the symphysis pubis and out through the perineal fistula. It was decided to close the vesical orifice of this fistula, and the edges were therefore thoroughly excised, the bladder wall separated from the symphysis to which it was very adherent, the tract and sinus thoroughly curetted and the vesical orifice of the fistula closed with a continuous through and through chromocized catgut suture (figure 13). The prostatic orifice was then

tightened by excising the mucous membrane posteriorly and drawing the muscle together from each side as usual, two interrupted sutures being used. After closing the bladder and supplying suprapubic tube drainage, the patient was placed in the perineal position and the scar tissue surrounding the perineal sinus was excised. The urethra was found to be widely dilated and redundant, and the fistula which connected with the anterior wall of the bladder was discovered and thoroughly curetted and the tissues around it partly excised. The muscle structures in the region of the triangular ligament were evidently badly injured and no evidence of the external sphincter could be made out. The redundant urethral mucosa was then excised and muscle tissue drawn together so as to restore, as much as possible, the external sphincter. Although there was much more scar tissue and destruction of normal tissues than usual, a fairly good approximation was obtained, three layers of chromicized catgut sutures being placed and the skin left open and packed loosely with iodoform gauze. The suprapubic tube was removed at the end of a month, after which patient began to void through the urethra and micturition slowly but steadily improved. Patient was discharged July 16, 1921 with both perineal and suprapubic wounds well healed, able to retain urine two to three hours with good control, voiding naturally and a good stream. Has occasional leakage and has slight incontinence at night. Condition steadily improving.

September 1921. Patient reports for examination. All wounds are healed. Micturition is quite normal, patient voiding naturally and with no incontinence. General condition excellent.

Case 6. J. F. Age thirty-four. No. 10365, Brady Urological Institute Was admitted March 17, 1922 complaining of incontinence following injury. No history of venereal diseases. On November 6, 1919 patient fell from a telegraph pole, fracturing the pelvis and rupturing the bladder. At operation a perineal drainage tube was inserted and fracture of the pelvis treated by fixation with sand-bags. After ten days the tube was removed but the fistula persisted and patient had complete incontinence. In May, 1921, he was operated upon elsewhere, the fistula excised, the stricture dilated and drained again through the perineum. Tube was removed within ten days and retention catheter inserted through the penis. The fistula closed only for about two weeks; since then it has been open, and for a time there was frequent urination during the night and incontinence during the day. Urination gradually became more difficult, and for six months patient had frequent

attacks of complete retention of urine, requiring catheterization. At other times he voided with difficulty and marked frequency. When the bladder became full there was incontinence and patient was unable to control his bladder, although voiding with marked frequency.

On examination, patient was wearing a retention catheter. In the perineum there was a broad scar in the center of which there was a fistula. Prostate was about normal in size but adherent. The vesicles were slightly thickened and adherent. Base of the bladder was negative. Catheter was introduced and cystogram taken. Bladder capacity 600 cc.

Cystoscopy. Cystoscope enters with considerable difficulty apparently meeting an obstruction near the vesical orifice. Study of the internal orifice shows no anterior cleft, lateral lobes not hypertrophied intravesically. On looking posteriorly towards the right one sees a cleft which is apparently a tear through the internal sphincter. The cystoscope can be withdrawn into the urethra where much scar tissue can be made out. The bladder mucosa is everywhere markedly congested, and the trigone can not definitely be seen. There is no trabeculation, no tumor, stone, ulcer, etc.

Operation. March 22, 1922. Colston. Suprapubic Cystostomy excision of fistulous tract on anterior wall of the bladder; closure of bladder with chromicized catgut; suprapubic drainage. When the bladder was opened, the condition present is graphically shown in figure 14. As is seen here, there were two openings on the anterior wall of the bladder which were found to be separated by small septum of fibromuscular tissue which was completely excised, thus producing one orifice in the bladder. Investigation then showed that the fistulous tract opened into the urethra in front of the prostate, probably through the anterior part of the membranous urethra. The prostatic orifice was apparently normal but there was a stricture at the apex of the prostate, and a sound introduced through the meatus passed through the fistulous tract into the bladder. It was through this that the cystoscope had been introduced. The fistulous tract was excised as completely as possible and then thoroughly curetted and closed by two layers of interrupted catgut stitches which were placed with the Boomerang needle holder, as shown in figure 15, *A* and *B*. The obliterating stricture at the juncture of prostatic and membranous urethra was removed and large sounds were pased freely through this region into the bladder, apparently completely relieving the obstruction. The rest of the bladder was normal and nothing was done to the prostatic orifice. It was evident the incontinence was caused by the urine flowing out through the fistula.

A catheter passed through the urethra and into the bladder through the prostatic orifice, was left in place. Suprapubic drainage was also provided, the bladder wound being closed up to the point of drainage at the vertex. The recti muscles and skin were closed with interrupted stitches of silver wire.

The patient was then placed in the perineal position and the perineal fistula excised and closed with catgut.

Convalescence. Slow but fairly satisfactory. The catheter was removed after a week but later had to be reinserted after dilatation of the urethra with filiforms and followers. Within a month fairly normal urination with good control through the penis was obtained, but the suprapubic fistula reopened intermittently.

June 16, 1922. On discharge, the suprapubic wound had been healed for a week and the epididymitis from which he suffered was much improved. The patient was then voiding at intervals of four hours without hesitation or pain. The urine was cloudy and contained pus and cocci in abundance.

Remark. This case differs from the others in that, in addition to incontinence, the patient had intermittently complete retention of urine and required catheterization. This was due to complete closure of the prostatic urethra at the apex and recurrent contracture of the fistula through which the urine excaped, thus requiring dilatation with catheters. The patient was cured by excision of the fistula and removal of the stricture of the prostatic urethra.

GROUP III. INCONTINENCE FROM PERINEAL VESICAL FISTULA ASSOCIATED WITH DERMOID CYST OF PREVESICAL SPACE

One case of incontinence belongs in this group. I have never met with a similar case in the literature but cannot claim that the study has been exhaustive. Details of the case are as follows:

Case 7. J. C. Age thirty-six. F. 80522, Dispensary. Patient first came to the hospital at the age of thirty-six, complaining of frequency of urination, pain and a fistula in the right side of the perineum through which urine escaped. His history was briefly that at the age of nine years he had a fall on the street, following which he had an abscess in the right groin by the side of the scrotum. This abscess discharged pus and formed a fistula through which pus escaped but no urine. He also had abscesses elsewhere and a suppurative sinus on the outer side of the leg on the left side, in which subsequently dead bone was discovered, and

which during the future years would heal up and then open again and discharge pus; occasionally it would remain healed for two to three years. There was no urinary disturbance at this time. Ten years later at the age of nineteen, a piece of dead bone worked out through the fistula in the right groin. This bone was about the size of a lead pencil, and about 1 inch long. No stone, hair or other foreign body came through this fistula and no urine escaped at this time, but about five years later he began to have frequent leakage of urine through the sinus.

At this time there was no bladder trouble, no frequency, difficulty or pain. In 1904, at the age of thirty-four, he began to have pain in the bladder and shortly after, urine began to escape through the fistula in the groin. At times it was continuous and at other times it would cease for a period.

The frequency and pain in the bladder increased and at the end of two years was fairly considerable. He was admitted to the Johns Hopkins Hospital in 1906, was operated suprapubically and a stone the size of a chicken egg removed. No operation was done on the urinary fistula in the groin. About two weeks after leaving the hospital the patient returned with pain in the bladder and another stone was detected and crushed. After that the patient had no further pain in the bladder for three years, but urine continued to flow from the fistula in the groin.

On January 29, 1909, the patient came to the urological dispensary stating he had been passing stones with hairs attached to them at intervals for about a year. In one instance a hair eighteen inches in length came away with the calculus. In two other cases a calculus one inch long surrounding hairs had been passed. Cystoscopy was carried out and a long slender stone was seen hanging from the anterior wall of the bladder (fig. 16), apparently being held there by a hair which protruded from an opening which was visible on the anterior wall of the bladder. On March 10 this stone was removed with my cystoscopic rongeur by Dr. Geraghty. The hair was found to be about 3 cm. in length and surrounded by a calculus. Subsequently stones again formed and were seen hanging by hair from the anterior wall of the bladder. They were broken loose, crushed and evacuated. It was possible to pass a filiform through a fistulous opening in the right side of the perineum and the cystoscope showed that this filiform passed into the bladder through the opening from which the hair protruded and from which on various occasions calculi were seen to be suspended.

On June 5, 1910, he was admitted to the hospital (J. K., No. 2566, Brady Urological Institution) and operation was carried out by me on

June 17 under nitrous oxide. After opening the bladder suprapubically, the fistulous opening was found to be about 1 cm. in diameter and on the anterior wall about 2 cm. in front of the prosatatic orifice, slightly to the right of the median line (fig. 16). I inserted a finger into this orifice and felt an irregular calculus which was removed with the curette. This process was repeated and additional *calcareous material which contained hair was removed.* The total amount of calculus was about 1.5 cm. in diameter. Examination then showed a peculiar septum of bone which ran from one pubic ramus to the other, and between it and the pubic arch lay the cavity which contained the stone and hair above described. With bone forceps this bridge of bone was removed as completely as possible, but owing to its great depth, it was impossible to remove it all. Examination of the bladder showed nothing particularly abnormal. There was no stone present in the bladder. After excising the edges of the fistula, the bladder, was closed up to the vertex where drainage was provided by a large tube.

Convalescence. Patient had satisfactory convalescence and was discharged in good condition, but on March 6, 1913 he again returned to the hospital complaining of pain and the passing of calculi. Cystoscopy showed another calculus attached to the anterior wall of the bladder. This was removed by crushing, and on various occasions subsequent to this, patient returned with a history of passing calculi and several times stones were removed by litholapaxy.

Patient was next admitted to the hospital on April 22, 1920, J. C., No. 8808 Brady Urological Institute, complaining of frequency of urination, hematuria, suprapubic pain and dribbling of urine from a fistula in the groin. Cystoscopy showed a contracted bladder which was markedly inflamed but no stone was present. A fistulous opening was seen on the anterior wall of the bladder.

On May 3, 1920, under nitrous oxide, oxygen and ether, I carried out a suprapubic and perineal excision of the vesico-perineal fistula (fig. 17). The bladder was sutured with chromicized catgut, a large drainage tube provided at the upper angle. The deep perineal suprapubic tissues were sutured with two layers of continuous chromicized catgut and the skin of the perineum and groin closed with continous chromicized catgut, leaving a small point for drainage. At this operation no stone was found either in the bladder or along the fistulous tract. No hair or bone was detected.

On June 9, patient was discharged. The wound in the groin was healed and the suprapubic wound was very small only a few drops of

urine escaping through it. Patient was able to retain urine two or three hours without pain.

On July 6, 1920, the patient again returned with a fistula in the groin, and a probe detected rough bone, but when the wound was thoroughly curetted, no bone or tissue was obtained.

May 31, 1922. Since last note the fistula has opened from time to time, but no stones have formed since the operation in 1920. The urinary fistula has now been closed for six weeks and patient voids urine freely without pain or discomfort. He has passed no hair, calculi or bone fragments since operation in 1920. The prostate is about normal in size, smooth and elastic. The seminal vesicles are slightly indurated and adherent, and the fistula is apparently closed. Urine is still cloudy. Cystoscopic examination negative.

Remark. Accurate analysis of this case is difficult. It is quite possible that the history of accident at the age of nine is correct and that a fracture of the pelvis occurred which resulted in the bony exostosis which was found at operation in 1910; but this would not account for the presence of hair which was so frequently found surrounded by calculi and which was also found in the cavity adjacent to the bone at operation. Cleaning out this cavity and partial excision of the bone stopped the passage of hair, but calculi continued to form until a more radical operation was carried out in 1920. The frequent reopening of the fistula, however, would seem to indicate the continued presence of dead bone which can in fact, be felt with the probe and which is, I believe responsible for the recurrent perineal leakage. A still more radical operation will apparently be necessary to completely cure the recurrent urinary fistula.

GROUP IV. INCONTINENCE OF URINE ASSOCIATED WITH EPISPADIAS

This form of incontinence is not rare with epispadias, but very little concerning it has appeared in the literature. We have encountered this condition in three cases of epispadias, and examination in all these cases has shown a widely dilated urethra with absence of musculature along the superior wall, not only in the region of the prostatic urethra, but also in the region of the membranous urethra and triangular ligament. Urethroscopes and cystoscopes showed a marked dilatation of both internal and external sphincters (fig. 18) and the operative problem which was presented was to excise sufficient tissue in

order to tighten the urethra and restore sphincteric control of both external and internal sphincters. The operation which has been carried out is graphically shown in the accompanying illustrations (figs. 19–25). As seen here (fig. 19), a suprapubic incision was first made, and, when the bladder was opened, a widely dilated prostatic orifice was seen (insert *A*) in the depths of which the verumontanum could be made out. Examination showed that the superior wall of the urethra was thin and fibrous, and the finger could be passed out from the bladder through the dilated prostatic urethra and also through the membranous urethra into the deep bulbous urethra where it was met by a finger passed through the penile defect from without. It was thought necessary not only to excise the roof of the prostatic urethra but to continue this excision downward so as to include the roof of the membranous urethra, and in doing this it was found helpful to make a part of the excision through the dilated penile defect, as shown in figure 20. After sufficient tissue had been thus removed from the bulbous urethra down to the vesical cavity, approximation of the urethra was obtained by means of the Boomerang needle holder, first along the roof of the membranous and prostatic urethra through the suprapubic wound, as shown in figure 21, and also through the penile defect, as shown in figure 22. When this was completed, the urethra had been tightened at the prostatic orifice so as to resemble a normally closed internal prostatic orifice, and only a small instrument could be passed through the membranous urethra. No attempt was made in the first two cases to close the penile defect (epispadias) but suprapubic drainage was maintained for about three weeks in order to facilitate closure of the sphincteric plastics. At a subsequent operation the repair of the epispadias was carried out by means of the technique which has previously been published by the author.[3] The results obtained in these three cases have been satisfactory, as shown in the accompanying abstracts.

[3] Young, H. H., A new operation for epispadias. Jour. Urol., ii, no. 3, June, 1918.

Young, H. H., An operation for the cure of incontinence associated with epispadias. Jour. Urol., vii, no. 1, January, 1922.

Case 8. V. W. C. Age eighteen. No. 8583, Brady Urological Institution. Admitted March 3, 1920, complaining of deformity of penis and incontinence of urine (for complete history see Jour. Urol., vii, no. 1, January, 1922). On account of the complete epispadias and widely opened urethra, patient has not attempted sexual intercourse. Testes and epididymides were normal. Condition present is shown in figure 18.

Cystoscopy showed a markedly dilated prostatic orifice and also external sphincter.

On October 8, 1920, operation was carried out by the writer under nitrous oxide, oxygen and ether. The vesical orifice was found widely dilated and the verumontanum could be seen. A finger passed through the penile defect and met a finger passed through the prostatic urethra. There was practically complete absence of musculature anteriorly and the operation described above was carried out, the excision along the anterior wall being sufficiently extensive to reach muscle on each side and to make a fairly tight urethra both at the prostatic orifice and also in the membranous region when sutured. Suprapubic drainage was supplied but a catheter was not placed in the urethra.

During convalescence 1 per cent mercurochrome was injected in very small amounts through the suprapubic catheter and a few drops into the bulbous urethra. Infection was thus prevented. At the end of a month, the patient was able to void through the epispadias and had fair control. On December 8, a plastic operation to cure the epispadias was carried out according to the previously published technique which is shown in figures twenty-three and twenty-four.

On January 10, 1921, the following note was made: Suprapubic drainage continued; occasionally patient is able to void through the newly formed urethra and has good control.

February 11, 1921. Filiforms, followers and sounds passed into the bladder. Suprapubic sinus completely closed. Patient is able to void naturally.

May 17, 1921. Patient returns for observations. He is able to retain urine all night and voids at normal intervals during the day; has complete control. Libido and sexual powers are quite normal. Examination shows a normal looking glans penis with scar along the dorsum (fig. 25). Patient voids urine in a large stream, has perfect control and urine is sterile.

One year later. Patient reports condition as detailed above has been maintained.

Case 9. L. H. Age nine. No. 7677, Brady Urological Institute. Admitted April 23, 1919, complaining of deformity of penis and incontinence of urine which has been present since birth; otherwise entirely well. Scrotum and testicles normal. X-ray shows a wide separation of the symphysis pubis. Cystoscopes and urethroscopes show urethra to be widely dilated in both the membranous and prostatic portions. Prostatic orifice is largely dilated.

At operation on May 9, 1919, under nitrous oxide, oxygen and ether, a similar operation was carried out. The prostatic orifice was widely dilated and the verumontanum visible, and operation was directed against mainly the prostatic urethra which was excised along the roof as in a previous case, but the excision was carried deep enough to remove the roof of the dilated membranous urethra, and sutures were placed so as to draw together the muscle in this region as well as to form a tight prostatic urethra and internal vesical orifice. The anterior wall of the bladder was closed by continuous chromicized catgut sutures with drainage at the upper angle.

Convalescence. Suprapubic drainage was maintained for three weeks and then allowed to close, after which the patient voided urine naturally through the urethra. Four weeks after operation he was able to retain urine four hours, voided freely and with good control.

May 2, 1920. Patient returned for plastic cure of epispadias which was carried out as previously described, perineal urethrotomy with catheter drainage provided and maintained for eighteen days. At the end of a month patient was voiding urine normally through the newly formed penis with complete control at intervals of four hours. Plastic results excellent; appearance of penis almost normal.

May 15, 1921. One year since operation. Patient is able to retain urine for four hours and has perfect control. Has not had instruments passed since operation. General health excellent.

Case 10. F. H. Age twelve. No. 9659, Brady Urological Institution. Admitted May 10, 1922, complaining of complete epispadias and incontinence of urine, present since birth. At a previous operation partial urinary control had been obtained, but when the suprapubic opening was made, the internal orifice was found to be somewhat dilated and it was thought best to excise the roof of the urethra and make a much more extensive dissection, particularly in the region of the membranous urethra and triangular ligament. In this case the sutures were placed beneath the pubic arch from the penile side with the Boomerang needle

holder, the first stitch being placed at the prostatic orifice and continued downward along the prostatic and membranous urethra and a part of the bulbous urethra until the urethra had been brought together tightly around a ureteral catheter which was left in situ. This line of sutures was reinforced by one or two stitches beneath the symphysis pubis. Inspection suprapubically then showed a tight vesical orifice and the bladder was closed by a continuous chromicized catgut suture with drainage at the upper angle. Plastic operation to close the epispadias was carried out at the same sitting, by the technique previously described. An excellent plastic result was apparently obtained.

Convalescence. Ureteral catheter was removed from the urethra on the sixteenth day. Suprapubic drainage was maintained for thirty days. Patient began to void through the urethra on the twenty-second day and showed evidence of good control. Suprapubic wound closed on the thirty-fifth day and on the thirty-ninth day (now) patient is able to retain urine for one-half to three-quarters of an hour, voids freely with good stream and has no evidence of incontinence. The plastic of the penis shows an excellent result, urethra normally placed, glans and corpora cavernosa well approximated in front of the urethra; appearance almost normal.

These three cases of incontinence of urine, associated with epispadias and due to a congenital lack of sphincteric musculature along the anterior wall in the region of both internal and external sphincters, show that remarkable results can be secured when wide excisions and proper approximation of muscle are obtained and the sutures carefully placed. These cases and those of the previous three groups described above show conclusively that even after great traumatism, extensive destruction of both internal and external sphincters, and in the presence of much scar tissue, it is still possible by means of thorough plastic operations to cure incontinence and obtain normal micturition. In some cases the defect is posterior and excision of scar tissue and sphincteric plastics must be carried out along the floor of the urethra both through the suprapubic and perineal incisions. Where the defect is along the roof of the urethra as in epispadias, excision and plastic must be along the roof. Where incontinence is due to fistulae which parallel the urethra whether after fracture of the pelvis (group II), or from dermoid cysts of the prevesical

space (group III), the restoration of a normal urethra, excision of strictures and the closure of fistulae must be carried out, but if the internal and external sphincters have been injured, the operation must include plastic procedures to restore these sphincters as in group I. Each case is therefore a study under itself and the operation has to be varied according to the findings and conditions presented by the ten cases detailed briefly above, in which excellent results have been obtained. From these cases, some of which were of very long standing, had been frequently operated upon and were in a deplorable condition, it is sufficient to say that with appropriately radical resection and thorough approximation of the muscle, the sphincteric defects can be repaired and practically normal function of the newly-made sphincters can be obtained.

FIG. 1. CONDITION PRESENT IN POSTOPERATIVE INCONTINENCE
Both internal and external sphincter widely dilated. Scar tissue in perineum

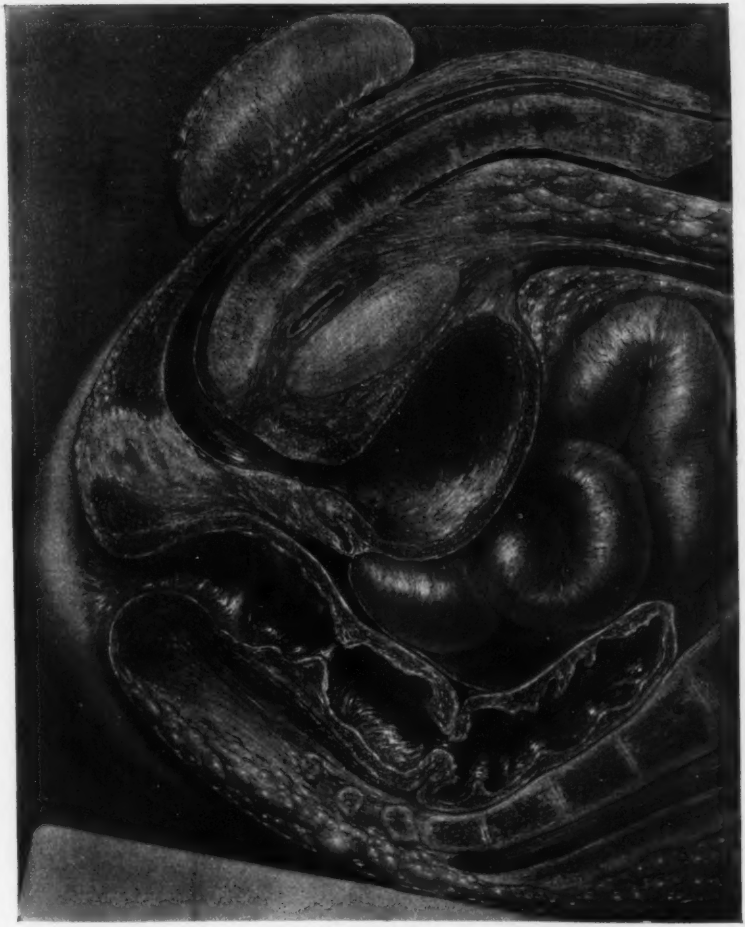


FIG. 1

FIG. 2. VIEW OF BASE OF BLADDER SHOWING DILATED INTERNAL VESICAL SPHINCTER

Insert *A* shows area denuded of mucous membrane, preparatory to suturing

FIG. 3. "BOOMERANG" NEEDLE HOLDER

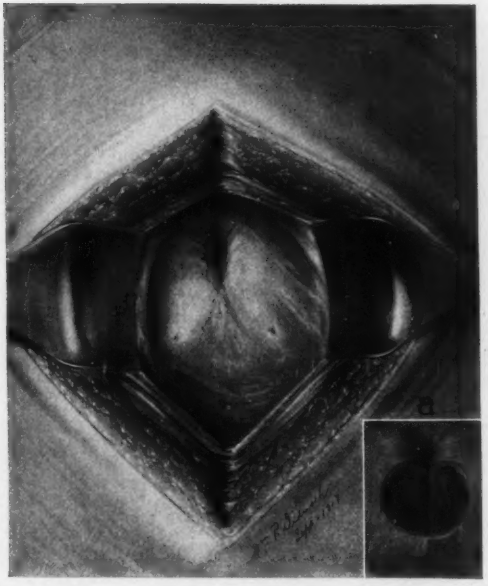


FIG. 2

FIG. 3

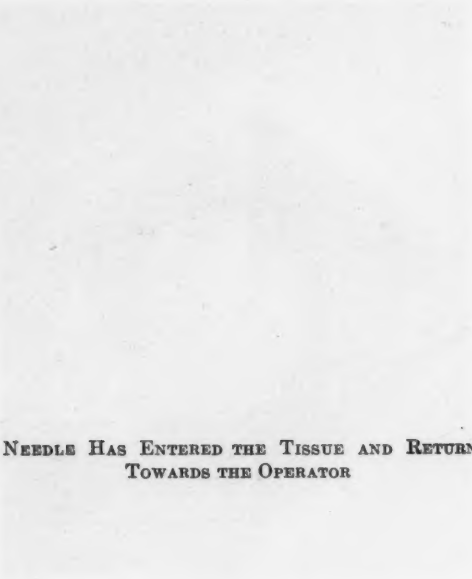


FIG. 4. THE NEEDLE HAS ENTERED THE TISSUE AND RETURNED, POINTING TOWARDS THE OPERATOR

FIG. 4

FIG. 5. NEEDLE HAS BEEN PULLED BACK BY RELEASED SPRING IN HANDLE OF INSTRUMENT, DRAWING SUTURE BACK THROUGH TISSUES

FIG. 5

FIG. 6. SUTURE-LINE AFTER COMPLETION OF PLASTIC OPERATION UPON INTERNAL SPHINCTER

FIG. 6

FIG. 7. SHOWING INCISION IN PERINEUM TO EXCISE SCAR TISSUE PRELIMINARY TO SECONDARY PLASTIC

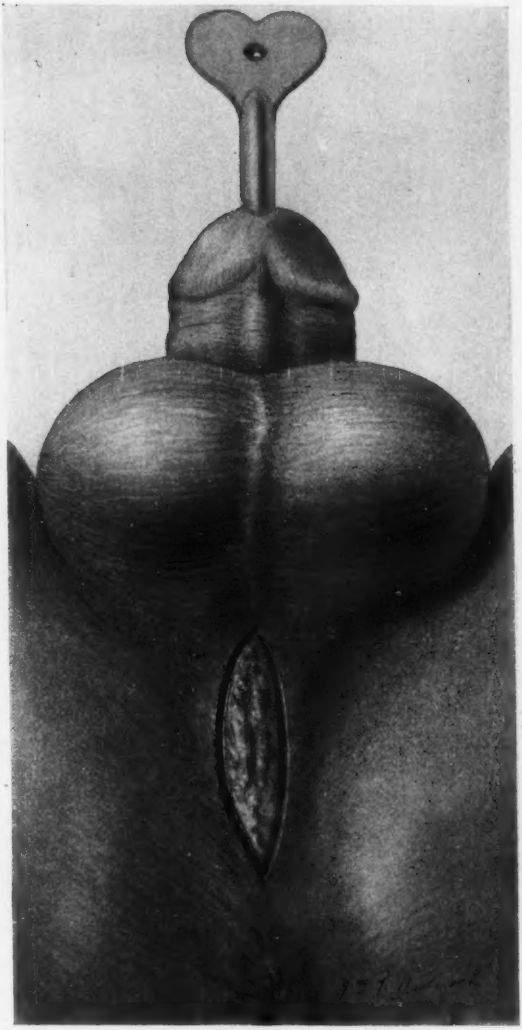


FIG. 7

FIG. 8. SHOWING DEEP DISSECTION AND EXPOSURE OF MUSCLE DURING EXCISION OF SCAR TISSUE

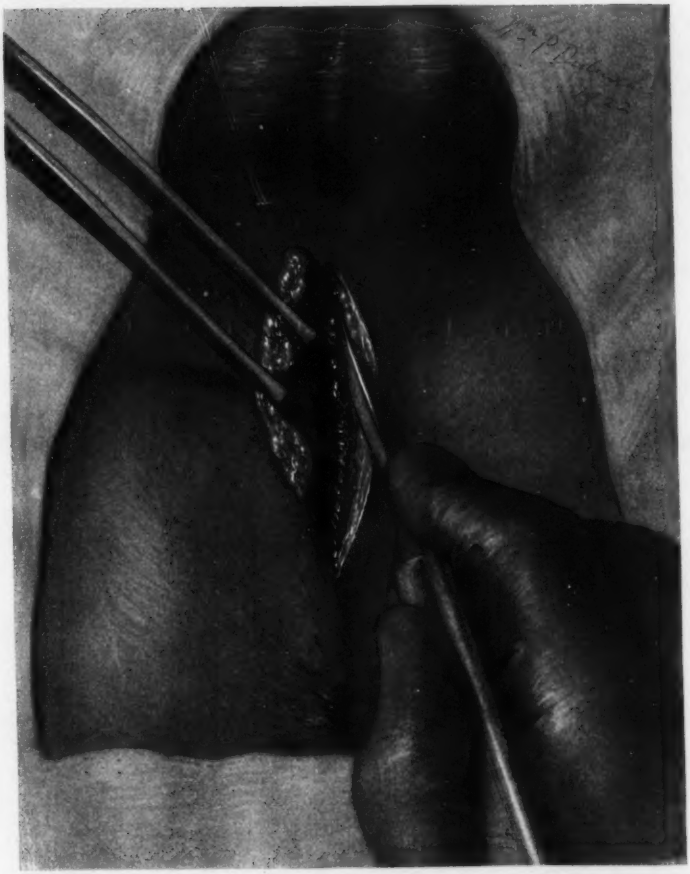


FIG. 8

FIG. 9. EXCISION OF REDUNDANT URETHRA IN REGION OF TRIANGULAR LIGAMENT AND EXTERNAL SPHINCTER

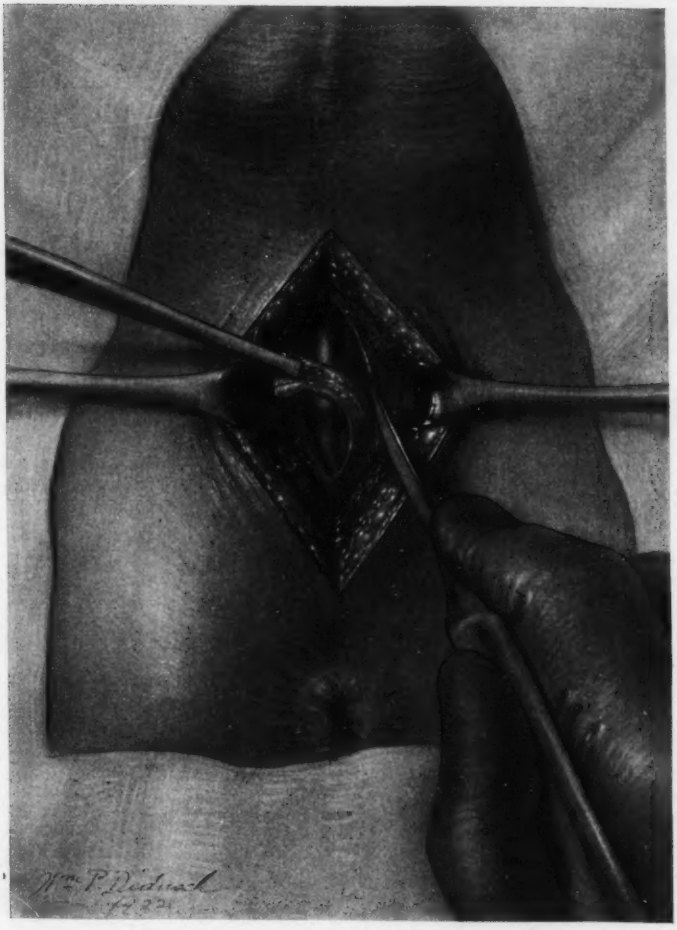


FIG. 9

FIG. 10. CLOSURE OF MEMBRANOUS URETHRA WITH "BOOMERANG" NEEDLE HOLDER

Mucous membrane inverted. Insert *A*, approximation of deep perineal muscle around urethra; insert *B*, closure of superficial muscle and fascia. Skin left open.

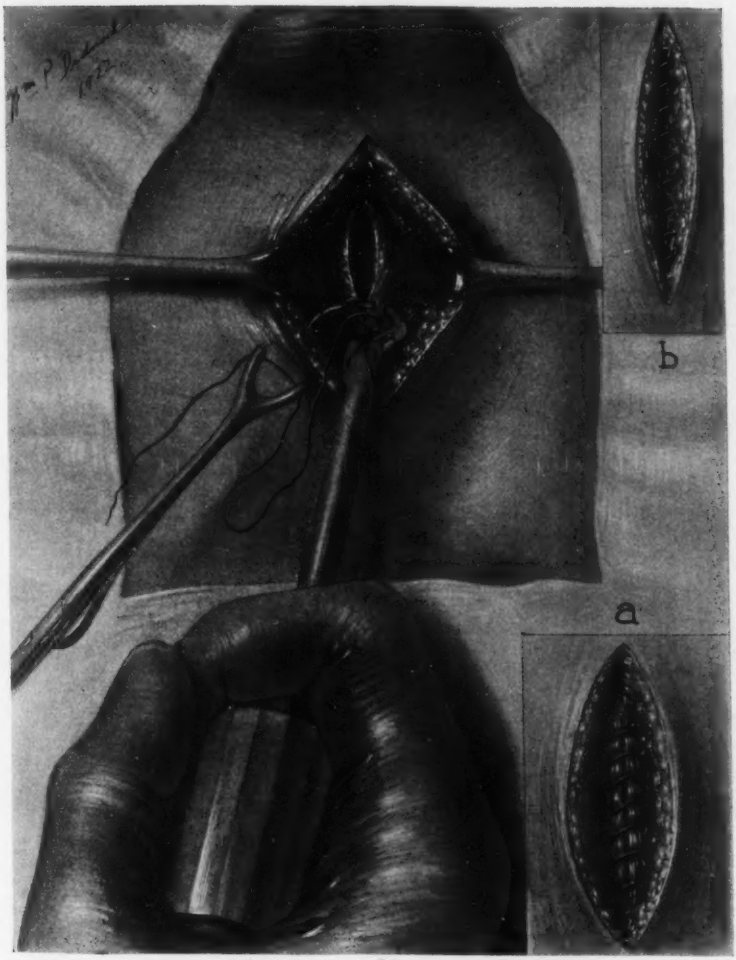


FIG. 10

FIG. 11. LONGITUDINAL SECTION SHOWING PRESENCE OF VESICAL AND URETHRAL CALCULI AND FISTULA PARALLELING PROSTATIC URETHRA AND LEADING FROM ANTERIOR WALL OF THE BLADDER TO THE BULBOUS URETHRA

Both internal and external sphincter dilated. Perineal fistula

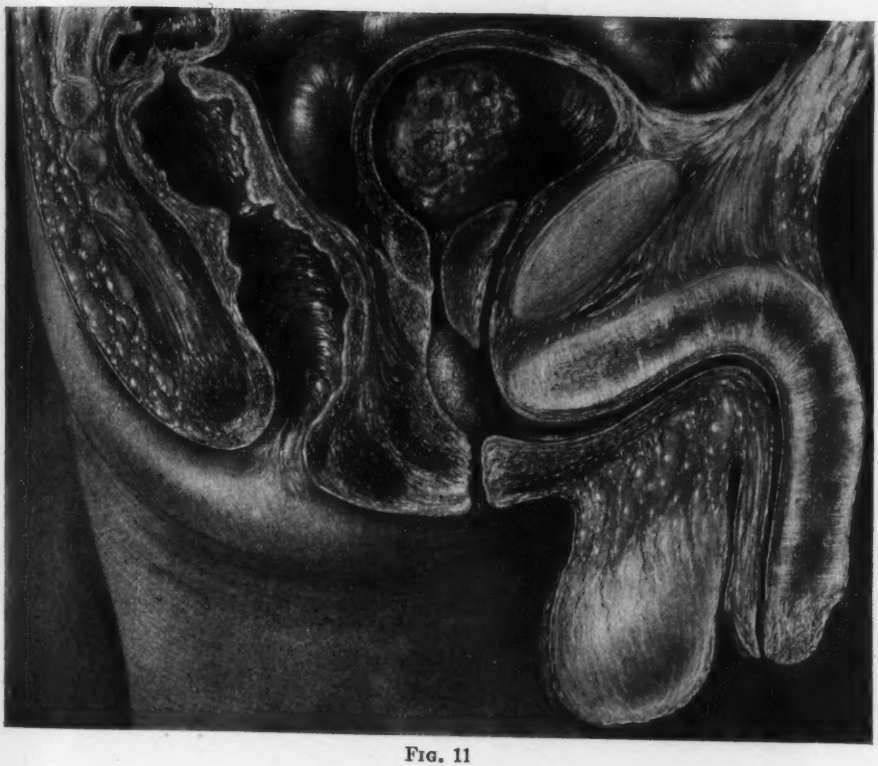


FIG. 11

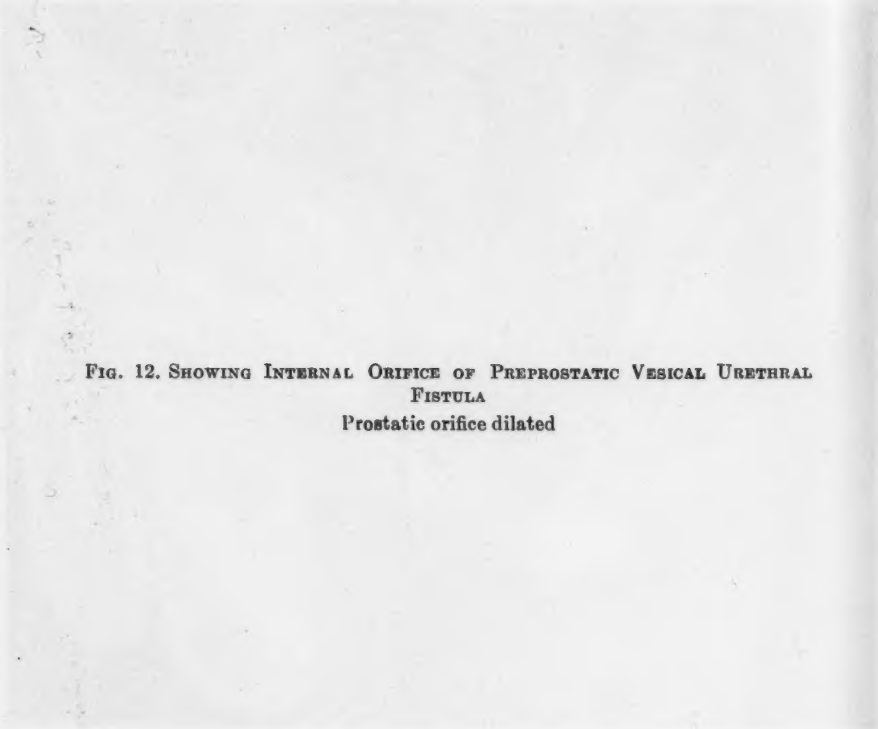


FIG. 12. SHOWING INTERNAL ORIFICE OF PREPROSTATIC VESICAL URETHRAL FISTULA
Prostatic orifice dilated

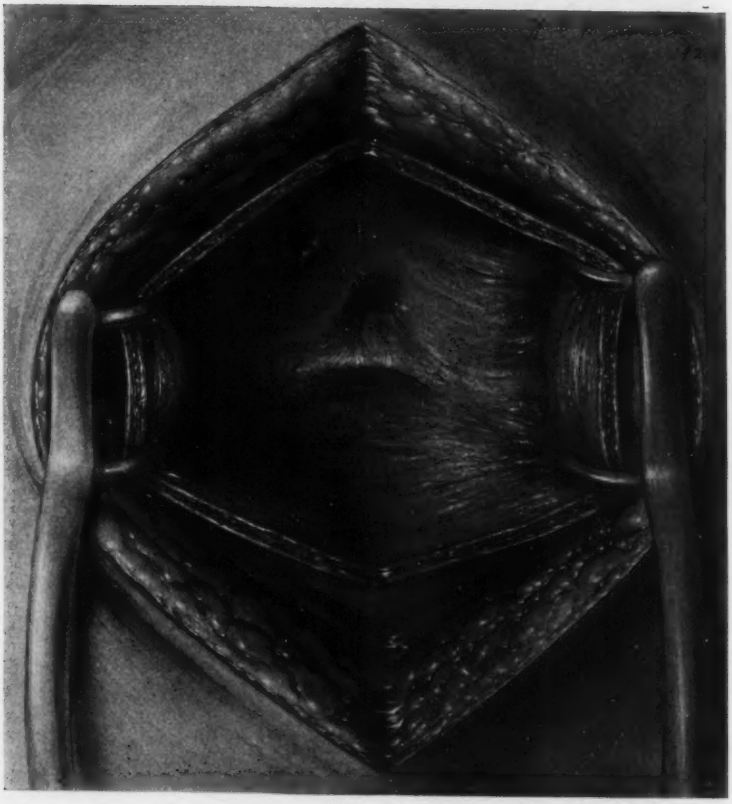


FIG. 12

FIG. 13. *A*, EXCISION OF FISTULOUS TRACT; *B*, CLOSURE OF VESICAL ORIFICE OF FISTULA

FIG. 14. LONGITUDINAL SECTION SHOWING PREPROSTATIC VESICAL URETHRAL FISTULA WITH TWO ORIFICES IN BLADDER

Obliterating stricture at apex of prostate.

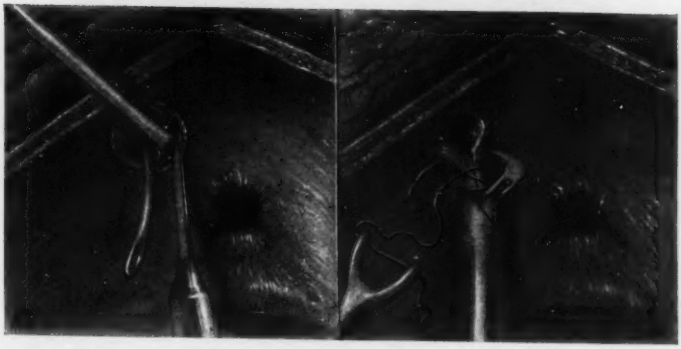


FIG. 13

FIG. 14

FIG. 15. *A*, EXCISION OF MARGINS OF FISTULAE AND INTERVENING SEPTUM; *B*, CLOSURE OF VESICAL ORIFICES OF FISTULAE IN TWO LAYERS

FIG. 16. SHOWING THE SLENDER CALCULUS SURROUNDING HAIR WHICH PROTRUDED FROM PREVESICAL SAC

A, Showing the relation between this hair and cysted calculus of prevesical dermoid cyst, as found subsequently at operation.

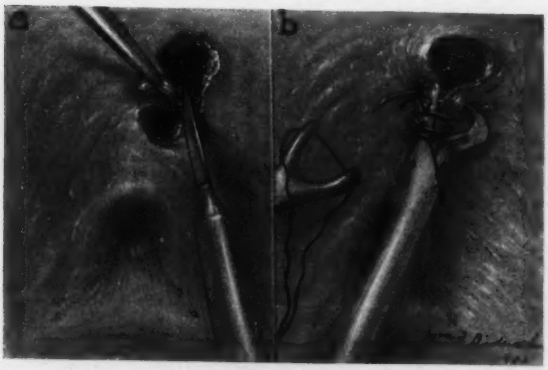


FIG. 15

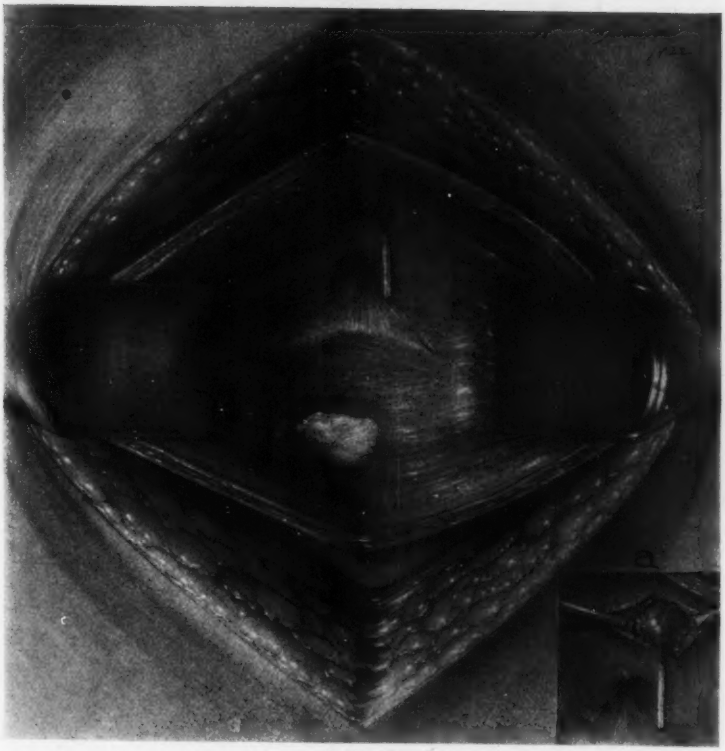


FIG. 16

FIG. 17. LONGITUDINAL SECTION SHOWING THE COURSE OF FISTULA FROM BLADDER TO GROIN WHICH WAS COMPLETELY EXCISED AND CLOSED INTERNALLY AND EXTERNALLY

FIG. 17

FIG. 18. SECTIONAL VIEW TO SHOW THE DILATED PROSTATIC ORIFICE (INTERNAL SPHINCTER) AND MEMBRANOUS URETHRA (EXTERNAL SPHINCTER)

FIG. 18

FIG. 19. *A*, DILATED CONDITION OF PROSTATIC URETHRA AND ATROPHY OF THE TRIGONE

Excision of anterior wall of dilated prostatic urethra also shown

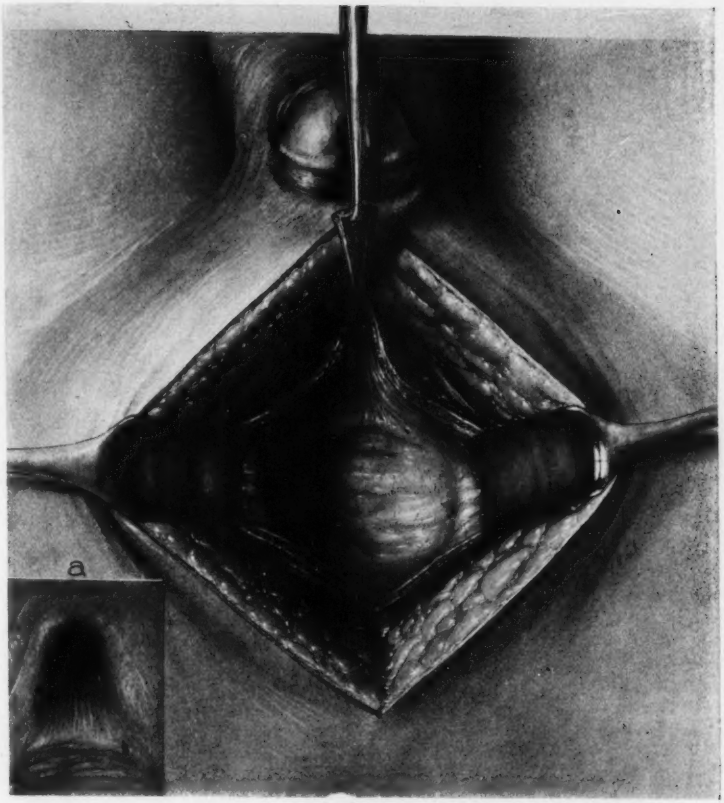


FIG. 19

FIG. 20. THE ROOF OF MEMBRANOUS URETHRA EXCISED THROUGH EPISPADIAC CAVITY

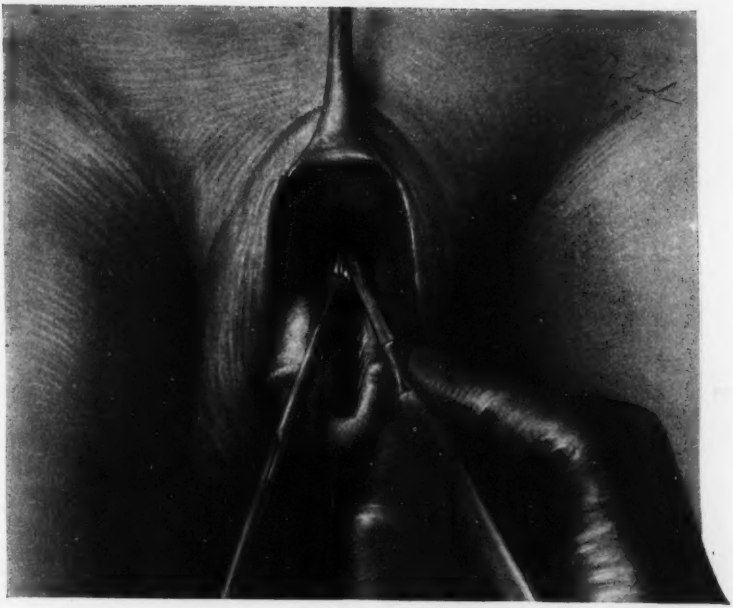


FIG. 20

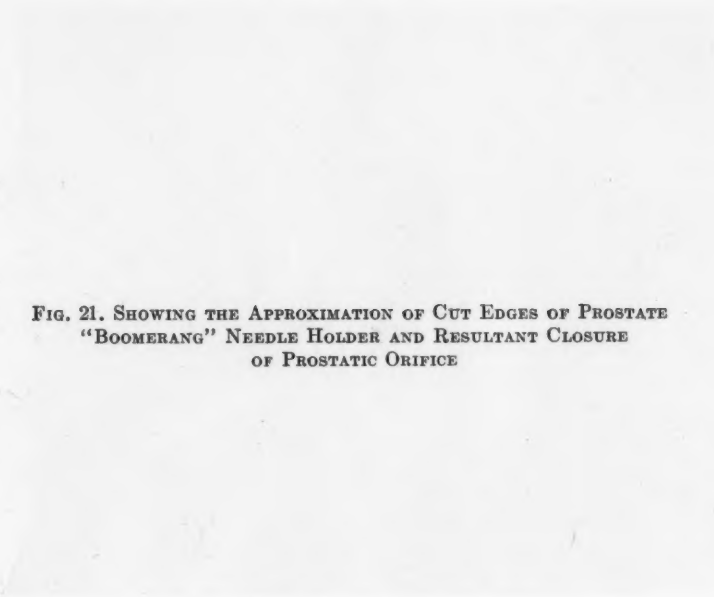


FIG. 21. SHOWING THE APPROXIMATION OF CUT EDGES OF PROSTATE "BOOMERANG" NEEDLE HOLDER AND RESULTANT CLOSURE OF PROSTATIC ORIFICE

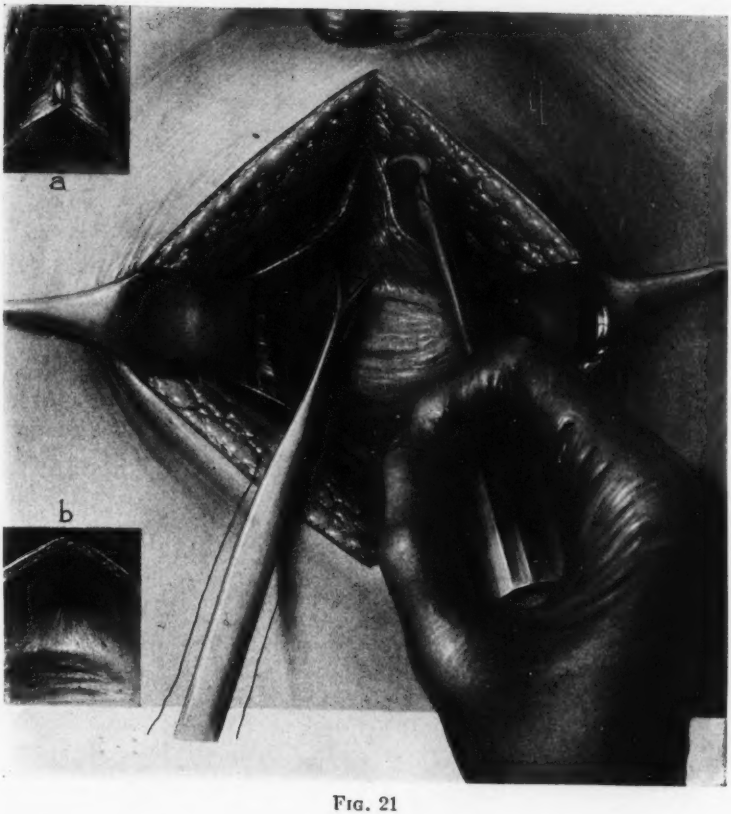


FIG. 21

FIG. 22. APPROXIMATION OF ROOF OF MEMBRANOUS URETHRA WITH CONSEQUENT CLOSURE OF THE EXTERNAL SPHINCTER

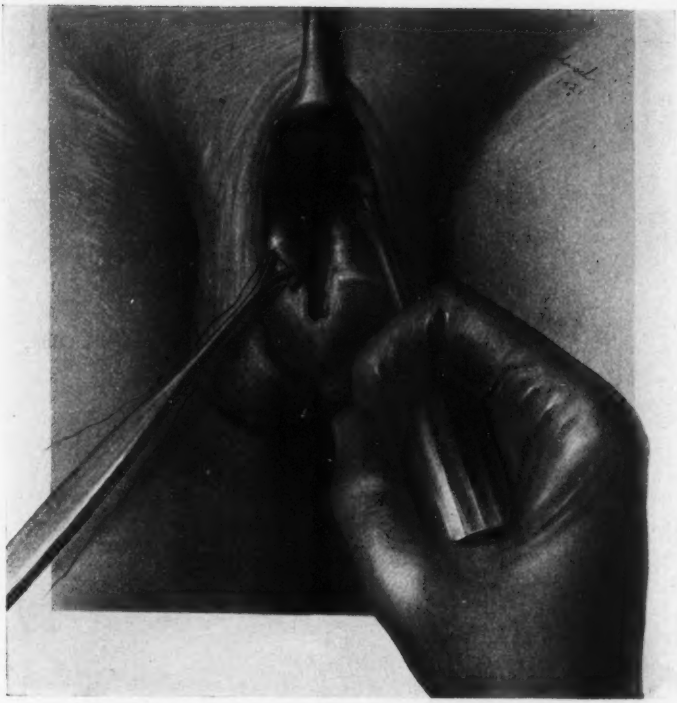


FIG. 22

FIG. 23. THE NEW URETHRA IS BEING FORMED BY CONTINUOUS SUTURE, BRINGING TOGETHER, OVER A CATHETER (*Ca*), THE EDGES PRODUCED BY THE ORIGINAL INCISION, AND CONVERTING THE ORIGINAL GROOVE INTO A TUBE

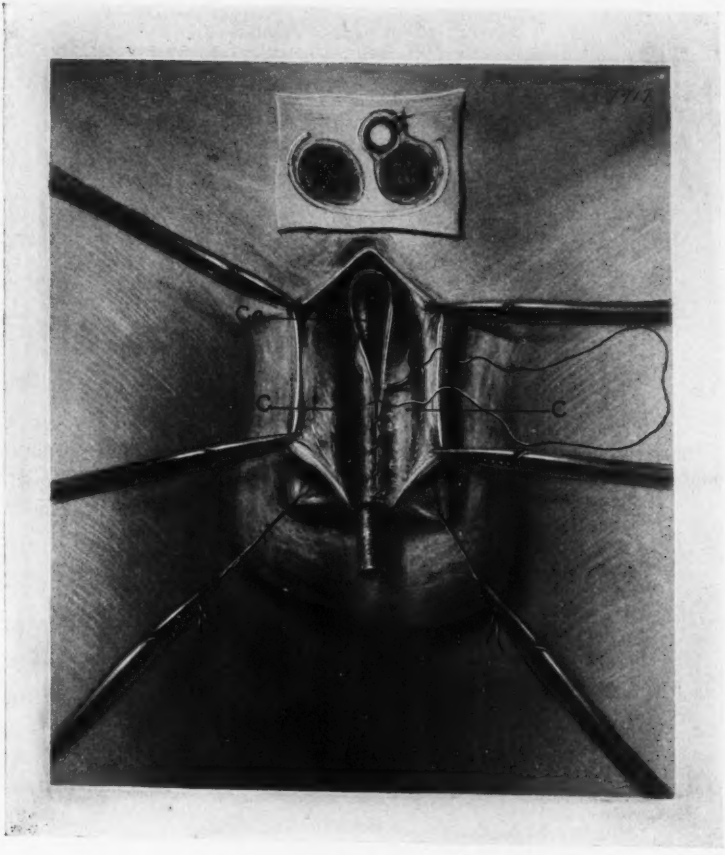


FIG. 23

FIG. 24. THE OPERATION COMPLETED

The two outer edges of the original incision were easily brought together at the midline making a penis and glans almost normal in appearance.

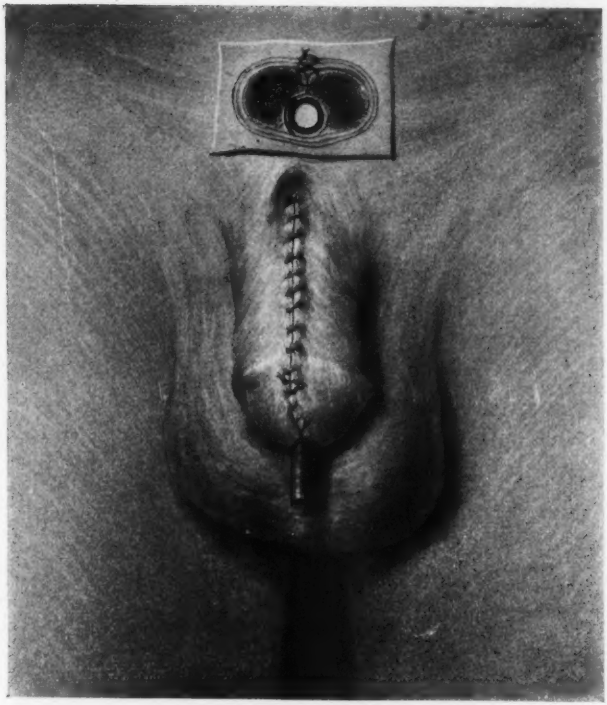


FIG. 24

FIG. 25. RESULT SEVEN MONTHS AFTER CURE OF EPISPADIAS
No fistula, no stricture, perfect urinary control, sexual powers normal

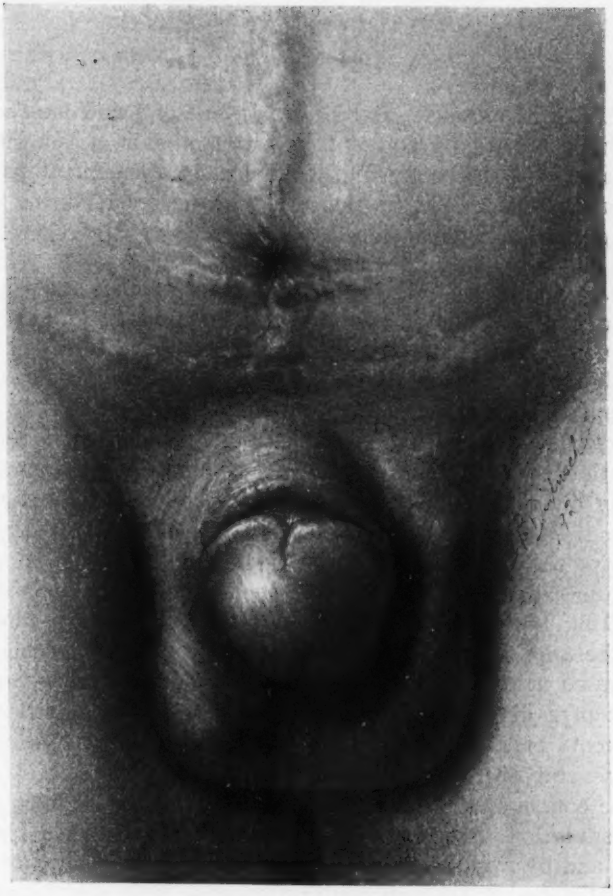


FIG. 25

DISCUSSION

Dr. J. T. GERAGHTY, Baltimore: In one of Dr. Young's cases which he apparently forgot to mention, repair of the internal sphincter was followed by little or no improvement at the end of three months. At the end of a year, however, during which time the sphincter had developed, there was good control.

Dr. E. L. KEYES, JR., New York: I think there is one principle to be borne in mind in operating on these cases. The patient with complete incontinence of urine seems to be and is in a deplorable condition and seems to have a tremendous leak. In the epispadias cases he has an actually large hole, but in cases of incontinence resulting from operations the difference between incontinence and continence is not the difference between a totally closed and an open water faucet but the difference between a trickling water faucet and a closed one. I think by studying the case as to the major element of the loss of muscular tissue and by attacking them as he has done or even without attacking both sphincters, one may get surprisingly good results because the leak sometimes is a very small one. I had this impressed upon me when a woman was referred to me who as a result of a difficult childbirth and tearing with obstetrical instruments had total incontinence of urine for seven years and had several operations to attempt to close this but in vain. In the course of the examination I thought I saw a little point of granulation tissue, a slight ulceration, right in the bladder neck, and by way of healing this up before attempting anything else I touched it through the urethroscope with acid nitrate of mercury. As a result she became continent, showing the difference between total and not total incontinence to be a slight one. Retention of urine did not last long, and then she wrote me that she again had a leak. I never heard from her again so that I do not know whether the improvement was permanent or not.

But it shows how slight a procedure will affect some cases. I have had three attempts at closing incontinent urethras all by the perineal operation. I attacked only the external sphincter. One ceased completely. Another one was a partial success and the last a total failure.

In regard to the dangers of pyelography there are three points to be considered: First, the nature of the fluid; second, the force of the injection; and third, the retention in the pelvis. Given a relatively unirritating fluid, given the method of gravity with slight elevation of the container, the question of irritation by the retained fluid remains the important one. Hydronephrotic cases are the most dangerous because we leave a quantity of our fluid in the pelvis, and thereby the kidney suffers.

Dr. Hagner and the other gentlemen feel shy on making pyelograms, and they say a pyelogram should not be employed unless you know that you need it. I do not know that I need a pyelogram until I have made a pyelogram.

A NEW METHOD OF PERINEAL PROSTATECTOMY WHICH INSURES MORE PERFECT FUNCTIONAL RESULTS[1]

A PRELIMINARY REPORT

JOHN T. GERAGHTY

Baltimore, Maryland

The prostatectomist of wide experience who is fair minded will concede that there are certain well defined indications for both the suprapubic and perineal operations. The popularity of the suprapubic operation, nothwithstanding its slightly higher mortality finds its explanation in the more perfect functional results in the hands of most operators, together with the greater experience necessary for skillful perineal dissection which the perineal method of approach requires. This latter objection to the perineal route however, deserves no serious consideration provided the perineal operation insures greater safety, more satisfactory convalesence and functional results which are equally good.

The object of this paper is to present a method of perineal prostatectomy, simple in its technique which should correct the occasional functional imperfections obtained by the methods now employed. We have observed for a long time that perfect urinary control following perineal prostatectomy could be expected in cases where the prostate was small or only moderately enlarged. When, however, there was great enlargement of the gland which is very frequently associated with a marked stretching of the internal sphincter, a partial incontinence lasting a few months and in an occasional case a permanent loss of

[1] From James Buchanan Brady Urological Institute, Surgical Department, the Johns Hopkins Hospital, Baltimore.

urinary control follows the operation. The degree of incontinence varies markedly. Usually when the patient is quiescent the urine is perfectly retained, but on suddenly rising with the bladder full, on coughing or sneezing or any sudden muscular exertion, small quantities of urine escape. This faulty control gradually disappears in most cases and in the course of six months to a year, more or less perfect control is regained.

It is now definitely known that the internal sphincter always lies outside and encircling the adenomatous masses, and consequently in very large prostates there is found marked relaxation and not infrequently atrophy of the fibers of the internal sphincter. This overstretching and atrophy which occurs in the internal sphincter is noted also in the intrinsic musculature of the prostate urethra, so that following the removal of a very large prostate, whether it be carried out by the suprapubic or perineal route, the prostatic urethra and internal sphincter never regain their former caliber and tone. Consequently continence of urine in these cases is dependent upon urethral and extrinsic musculature distal to the apex of the prostate.

It is established with certainty that no matter how large the adenomatous gland or to what degree atrophy of the internal sphincter or intrinsic urethral musculature occurs, incontinence rarely follows suprapubic prostatectomy. This fact has prompted a more careful study of the reason for this temporary difference in functional results following the suprapubic and perineal operations in very large prostates.

In the suprapubic removal of the prostate, the operators manipulations are confined within the prostatic capsule and none of the intrinsic or extrinsic musculature of the membranous urethra should be injured. In the perineal operation, as it is commonly performed, the external sphincter is either dislocated or divided before the membranous urethra can be opened. It may be stated that the technique of perineal prostatectomy usually employed involves the opening of the membranous urethra. The impossibility of exposing the membranous urethra without disturbing the position of the external sphincter can readily be seen by a glance at figure 1, showing the position

of the muscle and its relation to the membranous urethra. All anatomists are thoroughly in accord in their statements that the fibers of the external sphincter surround the entire length of the membranous urethra, even extending for a short distance into the prostate itself. If the membranous urethra is opened without stripping off the surrounding musculature, the fibers of the external sphincter must be divided; if, on the other hand, the muscle which encircles it is dissected forward or backward, considerable injury to this muscle may occur.

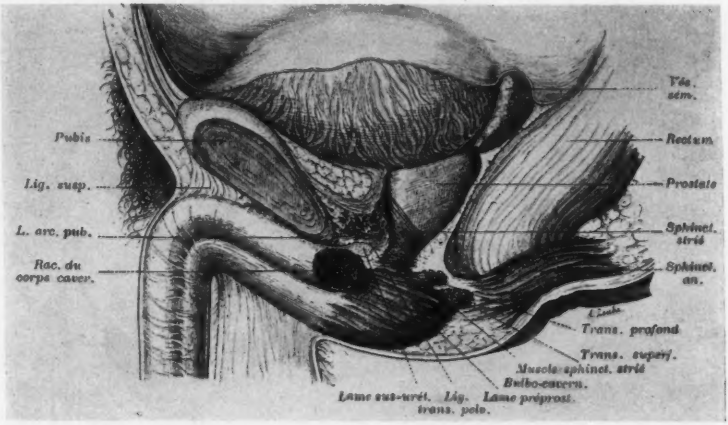


FIG. 1. (POIRIER AND SHARPY.) THIS SHOWS THE POSITION OF THE EXTERNAL SPHINCTER COVERING THE MEMBRANOUS URETHRA AND EXTENDING A CONSIDERABLE DISTANCE ON THE ANTERIOR SURFACE OF THE PROSTATE

It shows the impossibility of exposing the membranous urethra without cutting or dislocating this muscle.

It seems evident that if a method could be developed by which the prostate could be readily and well exposed without danger of injury to the membranous urethra and external sphincter, the occasional faulty functional urinary control following the present operation, especially when done on large prostates, might be corrected.

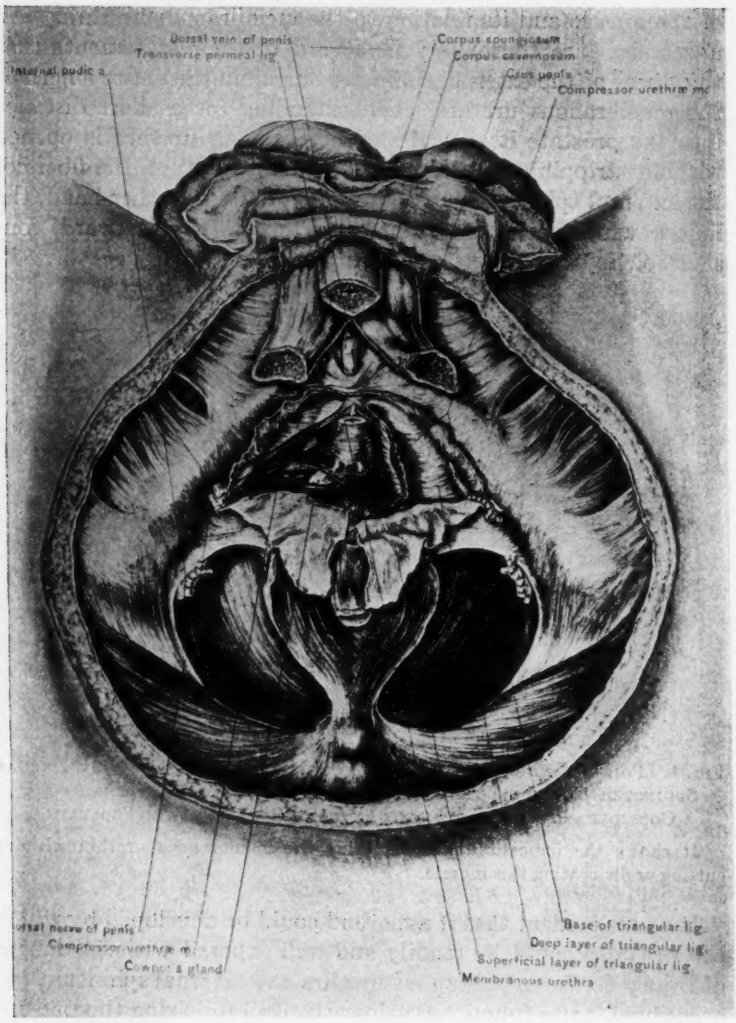


FIG. 2. (DEAVER.) ANOTHER VIEW OF THE EXTERNAL SPHINCTER SHOWING ITS POSITION AROUND THE MEMBRANOUS URETHRA

When the membranous urethra is opened this muscle must necessarily be injured.

TECHNIQUE OF OPERATION

The following technique has been carried out in a small series of cases with entirely satisfactory results. The patient is placed in the usual exaggerated perineal lithotomy position. A specially constructed prostate tractor is passed from the meatus into the bladder, the blades of the tractor opened and the handle carried toward the patient's abdomen. This tractor devised by Dr. Henry Freiberg differs from the Young seminal vesical tractor in possessing a curve and shape which facilitates its introduction into the bladder. It furthermore, upon the opening of its blades so engages the prostate that its flat surface rather than the sharp edge is in contact with the gland. This position of the tractor, using the symphysis as a fulcrum forces the prostate forward toward the perineum. A semicircular incision is made, the center of which is about an inch anterior to the anal margin. The ischio-rectal fossae are now opened with the finger and a bifid retractor introduced, each blade of the retractor occupying a fairly deep position in the fossa. When retraction is made, the central tendon is rendered tense and prominent. This structure is then divided close to the bulb, its division exposing the rectum. The rectum is now seen covering a varying amount of the posterior surface of the prostate (plate 1), and the recto-urethralis is seen holding the under surface of the bulb to the rectum at a point close to the apex of the prostate. This is not shown in plate. To facilitate the stripping back of the rectum, the finger is introduced anterior and lateral to the apex, the free margin of the rectum being readily picked up at this point. The rectum is now easily and safely freed from the prostate by finger dissection. The fibers of the levator ani are now separated in the midline in the region of the apex of the prostate by blunt dissection. The anterior fibers are now pushed laterally while those covering the body of the gland are pushed backward. The smooth, glistening visceral layer of Denonvilliers fascia is now exposed. It is evident from the foregoing description that the membranous urethra is not exposed and its musculature undisturbed.

A curved incision is made through the posterior layer of the prostate, the point of the curve being at the apex of the prostate and the legs extending downward in a divergent manner as shown in plate 2. The form of this incision preserves the flap containing the ejaculatory ducts and furthermore gives a maximum exposure of the hypertrophied lobes beneath. The line of cleavage between the capsule and the adenomatous masses is affected by the blunt dissector and the subsequent dissection carried out with the finger as is done in the suprapubic enucleation. The finger is carefully and gradually insinuated between the two layers, the anterior or apical portion of the lobes being delivered first. This facilitates the subsequent removal of the deeper portions of the gland especially the part which lies within the bladder. After the delivery of the apical portion of the lateral lobes, these portions are grasped with forceps, traction being then made. The suburethral and intravesical lobes are then carefully freed from their posterior attachment and from the grasp of the internal sphincter. If following the removal of the adenomatous mass which is usually possible in one piece, as recommended by Hinman (1) and Young (2) unusual bleeding is present, the mucous membrane edge is grasped with forceps and any bleeding vessels ligated. A large single tube is now introduced into the bladder through the opening of the prostatic capsule. Long strips of gauze are now packed tightly around the tube to a point well within the vesical orifice. The prostatic cavity is next snugly packed, the gauze being guided into its proper position by the finger.

It is well recognized by most prostatectomists that the most serious hemorrhage following prostatectomy arises from large vessels which lie in the overhanging flap of bladder wall from which the prostate has been separated. If care is not exercised in packing from the perineal side, this lip of bladder wall may be everted into the bladder cavity, and no hemostasis effected at this point by pressure of the pack. This accident may be avoided by grasping the edge of the overhanging lip of bladder wall with a mucosal clip, thus fixing it until the gauze pack has been inserted between the tube and vesical orifice. The observ-

ance of this technique will prevent eversion of the torn edge of the bladder and possible serious intravesical hemorrhage.

The tube is now sutured in the skin edge with heavy silk and the remaining portion of the skin incision approximated with subcuticular chromic catgut.

CONCLUSION

The operation described above has been carried out in a series of 10 consecutive cases. The exposure of the prostate by the technique above outlined simplifies rather than complicates the dissection. The method proposed differs essentially from the technique described by Young in that the membranous urethra is not exposed or at any time in the field of operation. Its intrinsic and extrinsic musculature as well as the nerve supply are neither disturbed nor injured.

REFERENCES

(1) HINMAN: Jour of Urol., vi, 6, December, 1921.
(2) YOUNG: Jour. Amer. Med. Assoc., April 1, 1922.

PLATE 1

The skin incision has been made and the recto-urethralis muscle divided. The rectum is shown in the bottom of the wound and the handle of the knife is stripping to either side the levator fibres that cover the prostate.

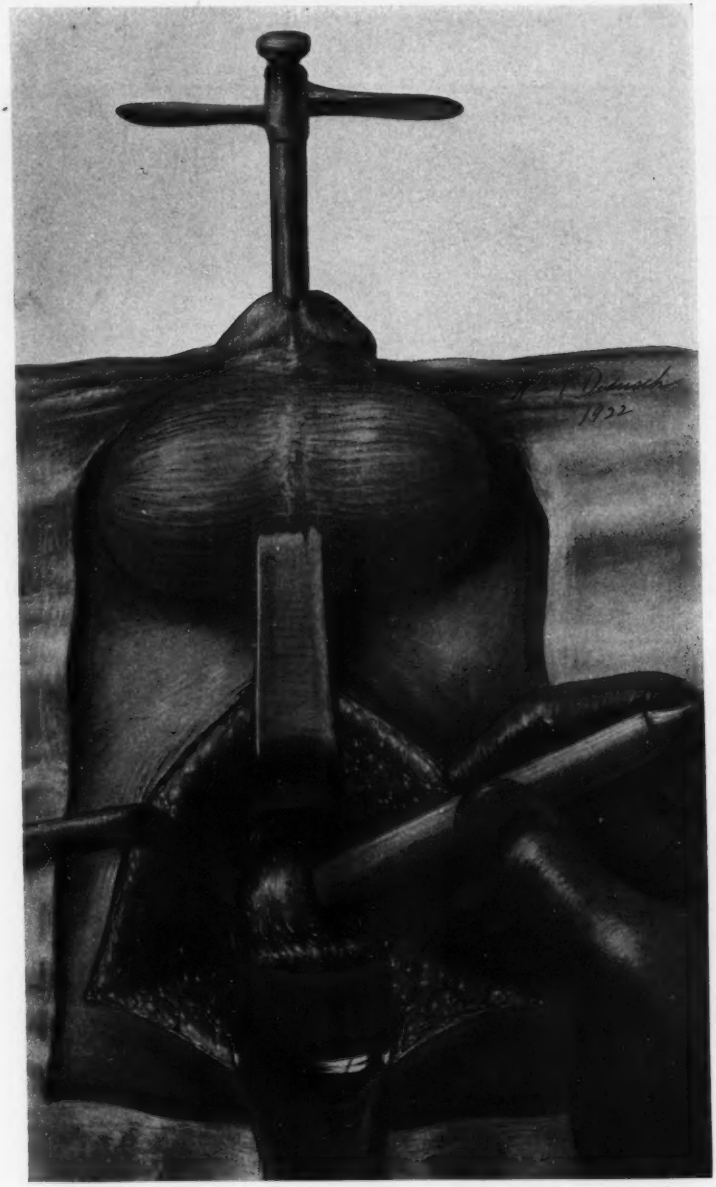


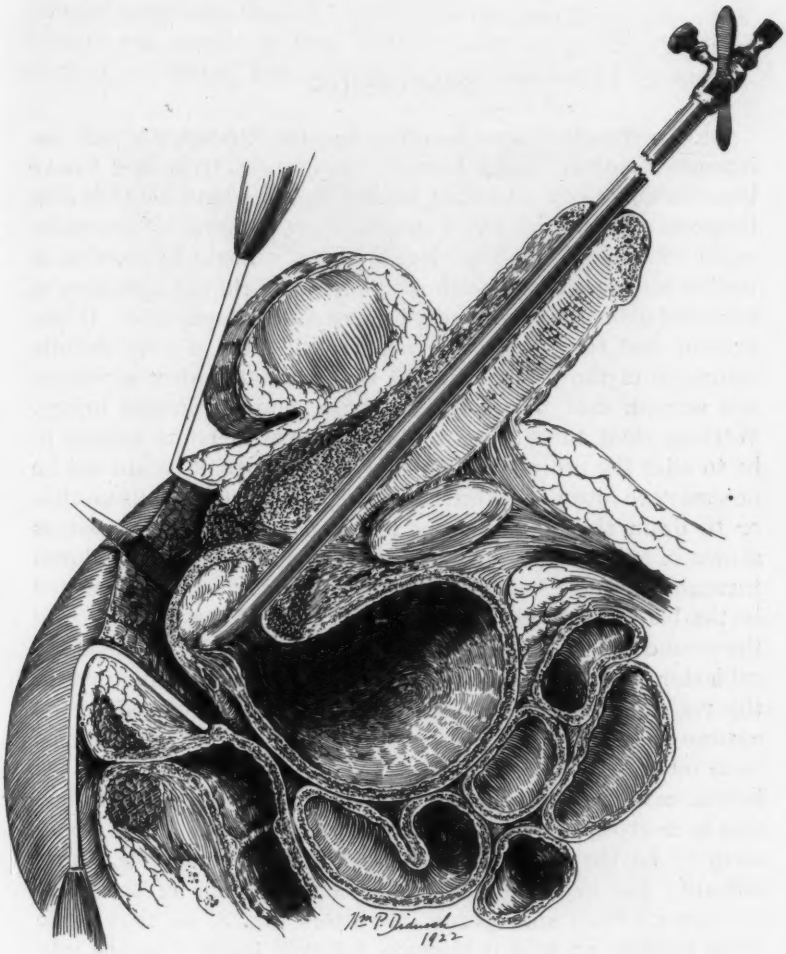
PLATE 2

The rectum is drawn backward, the levator muscles drawn outward and downward, thus exposing the posterior surface of the prostate. An inverted V incision is now made and the enucleation of the prostate carried out in the usual manner.

Wm. P. Didusch
1922

PLATE 3

A sagittal section showing the tractor in position and the relation of the rectum and membranous urethra to the prostate, forced into a new position by the tractor.


Wm P. Didusch
1922

DISCUSSION

Dr. Arthur B. Cecil, Los Angeles: Dr. Geraghty's talk has interested me very much because simultaneously he and I have been working along somewhat similar lines. I have long felt that the great genius which Dr. Young displays in doing his operation could not generally be expected, and that it might be possible to modify his procedure in such a manner as to rid the operation of technical difficulties and render it more widely applicable. It was evident that two things were necessary. First, a more definite assurance of the preservation of the external sphincter muscle, and second, that the rectum must be guarded against injury. Working along these lines, my first problem therefore seemed to be to alter the procedure in such a manner that it would not be necessary to introduce a tractor through the membranous urethra or to drain the bladder from this region. A tractor such as shown in figure 2 was devised. This could be easily introduced through the entire length of the urethra, and which when opened in the bladder would be efficient in bringing the prostate into the wound, thus avoiding any possibility of injuring the external sphincter muscle and avoiding unnecessary scar formation in the region of this muscle. A tractor devised much after the nature of this one except straight instead of curved, has also been found to be useful, as it may be introduced through the lateral cavity of the prostate for more efficient traction when this is desired. The only remaining technical difficulty would seem to be the dividing of the recto-urethralis muscle. This difficulty has been met by changing the handle of the shaft of Young's bifed and spatula retractors (fig. 3) so that while these tractors are held in position, a gloved finger is passed into the rectum to the apex of the prostate and the recto urethralis muscle is grasped with a clamp which is pushed down to the apex of the prostate under the sense of touch by the finger in the rectum (fig. 4). One may now cut above the clamp with

definite assurance that the rectum is not being injured. The levator ani muscle is then pushed aside as in Dr. Young's original procedure, and prostate may be enucleated by any of

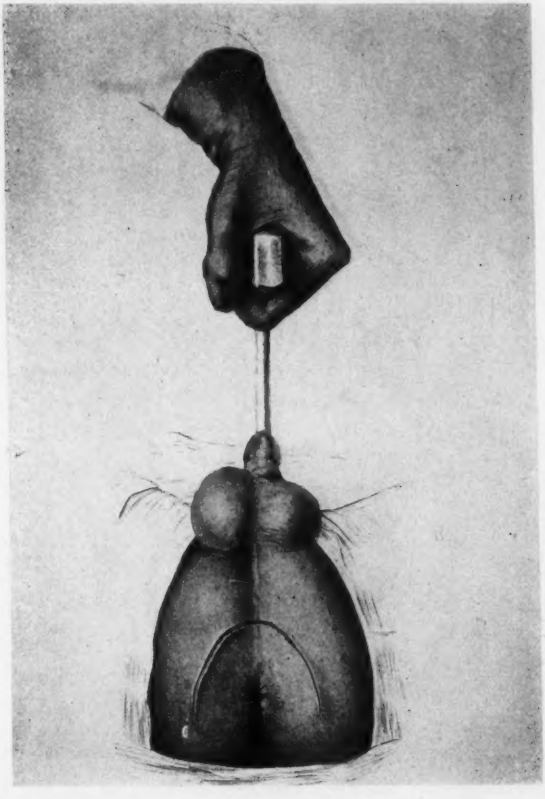


FIG. 1. TRACTOR BEING USED AS A SOUND, AND USUAL V-SHAPED INCISION

the methods that have been described (fig. 5). Drainage is carried out through one of the lateral cavities instead of through the membranous urethra. The usual closure, gauze packs, and post operative treatment as has been described

by Dr. Young, are carried out. The technique of this procedure is illustrated by the accompanying drawings.

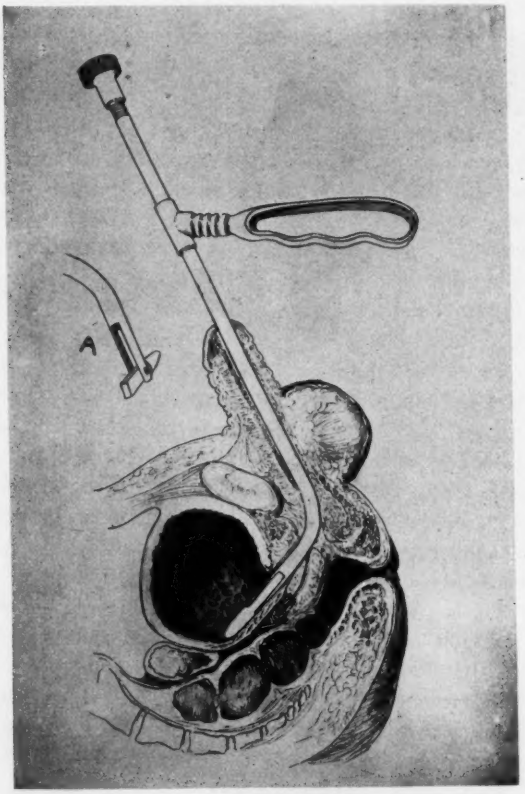


FIG. 2. SAGITTAL SECTION SHOWING POSITION OF TRACTOR IN THE URETHRA
A, VESICLE END OF TRACTOR OPENED

I might say that I have used a straight tractor devised along similar lines to my curved tractor, and this may be introduced through one of the lateral cavities after the prostatic urethra has been incised.

Dr. HUGH H. YOUNG, Baltimore: I have been greatly interested in Dr. Geraghty's presentation and Dr. Cecil's demonstration of his new instrument and a technique similar to that of Dr. Geraghty. The object of both, namely, to avoid opening the

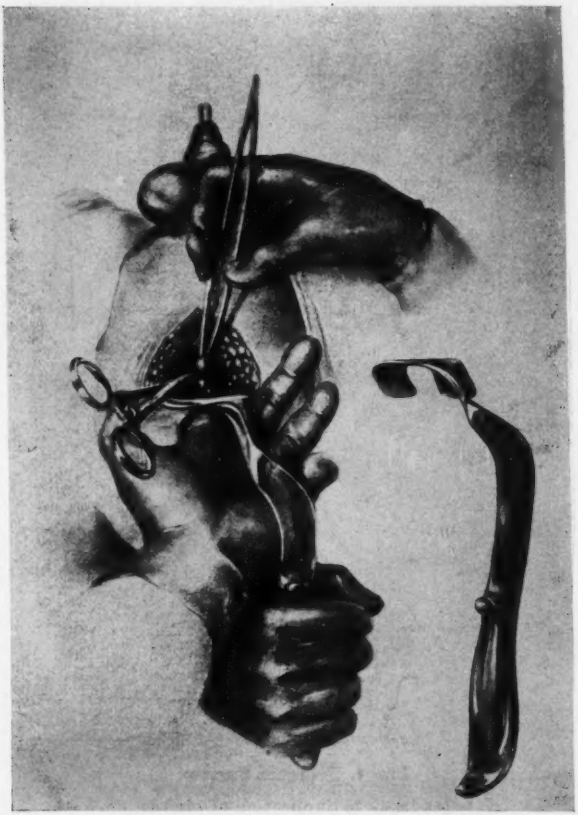


FIG. 3. POSITION OF SET-OFF BIFID RETRACTOR AND RECTO-URETHRALIS MUSCLE BEING GRASPED BY A CLAMP UNDER THE DIRECTION OF FINGER IN THE RECTUM

Previous to the division of the recto-urethralis muscle and exposure of the apex of the prostate.

membranous urethra and thus take no risk of injury to the external sphincter, is worthy of serious consideration.

If I may be pardoned for retrospection I will refer to some of the problems which I encountered many years ago when I

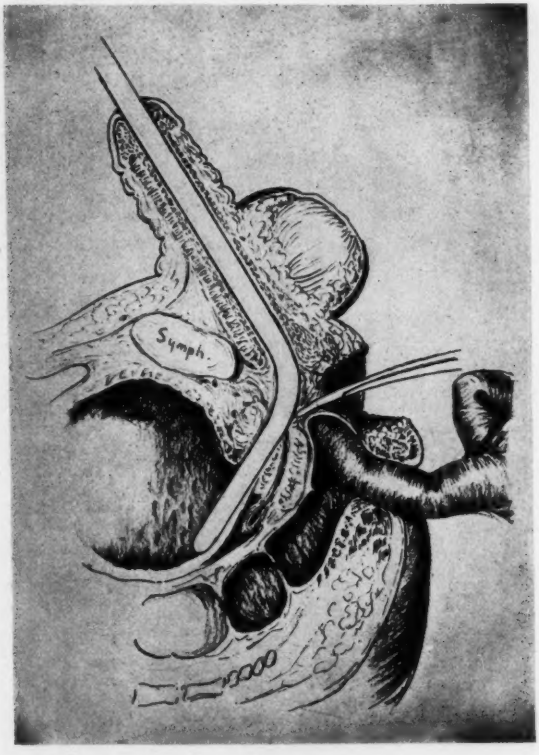


FIG. 4. SAGITTAL SECTION

Note tendency to duplication of the rectum.

carried out my first prostatectomies. At that time one had a choice between the suprapubic operation of Fuller and the perineal methods of Goodfellow, Watson, Alexander and Bryson. You will remember that Watson and Goodfellow removed the

prostate through a median perineal incision which passed through or greatly dilated the external sphincter and triangular ligament

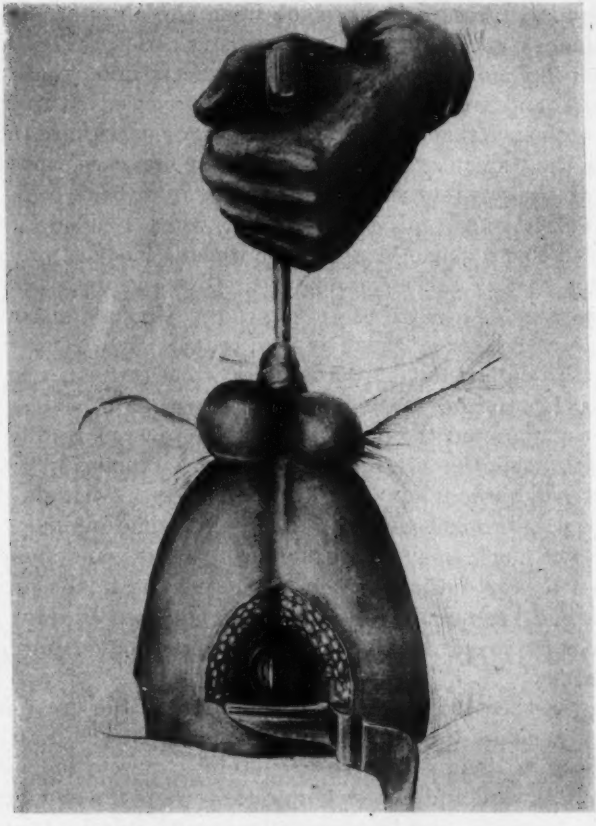


FIG. 5. PROSTATE DRAWN INTO THE WOUND

Lateral incision, splitting of the prostatic urethra for exploration of the vesicle neck and for drainage.

through which the prostate was removed, without the use of a mechanical assistance to bring down the prostate. Alexander proposed a preliminary suprapubic incision through which the

prostate was pushed with the fingers of the left hand while it was removed through the perineum; and Bryson proposed that this should be done by a suprapubic incision which did not open the bladder, pressure being made upon the anterior surface of the bladder to facilitate perineal enucleation. The median perineal incision, with its destructive effects upon the external sphincter and triangular ligament, was followed so frequently by incontinence that I determined to carry my perineal incisions back of the triangular ligament, and in the first case exposed and removed the prostate without assistance from below.

In 1902 I brought out an instrument, which I called a tractor, the first being a single bladed affair which I passed through the posterior part of the membranous urethra and drew down the prostate and enucleated it in one piece through an inverted "V" capsular incision, much as I do today. As this instrument frequently slipped out of the bladder while traction was made upon it, I naturally decided to make it with two blades, which rotated one around the other, and could be just as readily introduced through the urethrotomy wound. Practically simultaneously and without my knowledge De Pesser's minute desenclaveur was brought out in France and while similar to my tractor was much smaller and practically useless, and in fact was removed by the author as soon as the incision in the prostatic capsule had been made. It was really not used to draw down the lobes or to act as contrapressure and traction during the enucleation.

In my earliest papers I called attention to the great importance of avoiding the external sphincter and showed that it was possible after dividing the recto-urethralis muscle to push the rectum backward and expose the urethra where the membranous joins the prostatic, and by means of a special anterior triangular ligament retractor (which encircles the membranous urethra so as to draw the sphincteria fibers out of the way), I endeavored always to incise the urethra where it really consists of a thin membrane without encircling the muscle fibers.

In more recent years we have endeavored to go through the anterior part of the prostatic urethra, as also advocated by

Chute, thus avoiding completely any injury of the external sphincter. Nevertheless, I early realized that the ideal plan would be to avoid opening the urethra at all, consequently the bilateral capsular incisions were made parallel to the urethra through which the lateral lobes were removed without injury to the urethra and also with preservation of ejaculatory ducts and verumontanum. As a further step I also had my double bladed prostatic tractor made longer and more slender so it could be passed through the penile urethra, and attempted to carry out enucleation of the hypertrophied prostate through bilateral capsular incisions without any urethrotomy. I found, however, that the instrument was held so fixedly by the length of the urethra, the suspensory ligament and the triangular ligament, that free traction, especially upon pedunculated lateral and median lobes, was greatly interfered with and I, therefore, next tried to carry out the operation through an incision in the middle of the bulbous urethra (see Johns Hopkins Hospital Reports, xiv, case 12), but here again I found the manipulations of the tractor, which were desirable to draw down the hypertrophied lobes, were so markedly interfered with that I thought the inconvenience of the method outweighed the supposed value in avoiding the urethrotomy in the membranous urethra and possible injury to the external sphincter.

Several years later, however, when I promulgated an operative technique for the radical removal of tuberculosis of the seminal vesicles, vasa deferentia and lateral lobes of the prostate, the great importance of doing no injury to the urinary canal was so evident that I again employed the long urethral tractor and carried out the removal of the lateral lobes of the prostate, the seminal vesicles and vasa deferentia by means of traction with a long urethral double bladed tractor and without exposure of or injury to the external sphincter or the mucosa of the prostatic urethra, which were preserved intact. The exposure obtained was shown in the illustrations. Undoubtedly, in cases of tuberculosis it is very desirable to use a long urethral tractor and the prostatic lobes can be easily enucleated by this method. In some of my cases of tuberculosis the later lobes were also

hypertrophied, and no difficulty was experienced in carrying out the enucleation, but I am still of the opinion that I held sixteen years ago—that full mobility in the use of the tractor through the perineal wound is very desirable in facilitating the enucleation of intravesical lobes and I am also of the opinion that with care in going through the membranous urethra at the point where it enters the prostate and back of the external sphincter, which is possible in practically all cases, no cases of permanent complete incontinence of urine will be encountered.

In a report before the International Congress in London, 1911, I presented a very careful study of 450 cases, giving minute attention to urinary incontinence. Among these there was not a single case of complete incontinence, and only 3 with partial incontinence during the day and not at night. In at least one of these cases the cause of the incontinence was injury to the triangular ligament and external sphincter at operation, due to the fact that I mistakenly made my blunt dissection in front of, rather than behind, the transversus perinei muscles and thus arrived in front of the triangular ligament, which was injured along with the external sphincter in exposing the membranous urethra and prostate. The injury here was somewhat similar to that which was always encountered when the old median perineal operation was done and the incontinence, therefore, easily explained, but I am confident that if proper care is taken to avoid the external sphincter and open the urethra out from about the apex of the prostate, perfect success can be obtained in avoiding the external sphincter and any resultant incontinence. Temporary partial incontinence, particularly on coughing, sneezing or sudden movements, one sees after both suprapubic and perineal prostatectomy, but more frequently after the latter. This usually disappears in a few weeks or months.

The plan proposed by Dr. Geraghty and Dr. Cecil is most interesting and praiseworthy, and perhaps by our newer enucleating technique in which the entire adenomatous prostate is removed in one piece there is less need of individual traction upon the lateral and median lobes and, therefore, less necessity for

marked freedom of action with the tractor. The use, however, of these instruments will not absolutely guard against injury of the triangular ligament and external sphincter, because unless the operator is very careful to go back of the transverse perinei muscles and to divide the central tendon and recto-urethralis muscle properly, not only is it possible to injure the triangular ligament and external sphincter but also to get into the rectum, as shown in a recent case. In fact, injury of the rectum is a thing more greatly to be feared than incontinence of urine, but both of them can be prevented with almost absolute certainty if the proper care of the anatomical structures and a strict observance of technique is followed.

These papers show a praiseworthy respect for anatomical structures of physiological importance and demonstrate again that by means of the perineal route complete enucleation of the prostate can be carried out with the least functional harm. The splendid papers which have been recently produced by Hinman and Cecil have shown conclusively that the perineal is anatomically and physiologically, as well as surgically, the method of choice. It has long been accepted that the mortality is far lower in perineal prostatectomy.

Dr. Arthur L. Chute, Boston: For a considerable number of years I have made use of a modification of Dr. Young's procedure which I think carries out the idea brought forward in this paper; it helps those of us who are less expert than Dr. Young to avoid any interference with the external sphincter and therefore to avoid incontinence or weakness of control. I have been accustomed to make my incision for the introduction of the tractor through the tip of the prostate and use it much as Dr. Young uses his instrument. However, I do insert the tractor into the urethra through an incision in the tip of the prostate. The enucleation is then easily carried out through the usual lateral incision or a cross incision. I feel quite sure that by this modification I am less likely to injure the external sphincter either by trauma or inflammatory adhesions and therefore less likely to have any degree of incontinence.

Dr. H. G. BUGBEE, New York: I would like to say a word with regard to the control of hemorrhage in prostatectomy. We have been holding down the posterior lip of the prostatic ring, (the torn flap of the bladder wall) for a long time by using the Pilcher bag. It has been our custom of late to place a piece of packing posterior to the bag so that it would hold down this torn edge, and then hold it in place by light traction on the bag. This makes it possible to drain the bladder immediately after the operation through the tube which is passed out through the urethra. There are no clots to clog the tube, and the urinary drainage is only of a pinkish color. The light pull eliminates spasms of the vesical neck which were formerly so troublesome.

Dr. JAMES A. GARDNER, Buffalo: Dr. Keyes is too modest to mention his method of control but it has pleased me in talking with Dr. Geraghty to hear him point out that this flap of the bladder wall often is the cause of hemorrhage. I had watched Dr. Keyes this winter use the sponge holder and gauze which Dr. Barringer had brought out. Although I was familiar with the technic I had not used it until this time. After using the method I was astonished to find there was just a little pink drainage twelve hours after operation, and we did get rid of the spasms which occurred when the Hagner bag was used. Patients would complain of these frequent spasms every half hour until the tension from the bag was removed. We use the sponge holder with very little gauze but place it in the wound at such an angle that it is bound to push the flap down. The sponge holder is held in place by a piece of adhesive plaster. This method usually controls the bleeding on the evening following operation, so that we find we have the drainage pink in color without the patient complaining of the spasms.

Dr. A. J. CROWELL, Charlotte, N. C.: Just a word with regard to the packing. We use rubber tubing, perforated, and filled with gauze. It does not adhere to the surrounding tissue, as does the plain gauze and its removal is less painful to the patient and controls hemorrhage equally as well.

DIFFERENTIATION BETWEEN TUBERCULOUS AND NON-TUBERCULOUS INFLAMMATION OF THE EPIDIDYMIS

A. R. STEVENS

From the Urological Department of Bellevue Hospital, New York City

Received for publication August 10, 1922

The analysis of case records here reported was undertaken in the hope of securing dependable points of differentiation between tuberculous epididymitis and what might be loosely termed idiopathic epididymitis, i.e., those cases of non-tuberculous inflammation which have not followed operation or urethral instrumentation, and which have occurred in patients without gonorrhea or other gross urinary infection. It was desired also to estimate the value of certain features which we have from time to time thought helpful in differential diagnosis. This matter has been of particular interest to us at Bellevue Hospital, where we are repeatedly confronted with this diagnostic problem of non-gonorrheal inflammation of the scrotal contents.

This report is based on diagnoses made by microscopic examination of tissue removed at operation, and concerns 74 cases of genital tuberculosis, 35 of simple inflammation, and 4 of syphilis. Obviously, our notes on the occurrence of these conditions relate only to cases operated upon, and do not necessarily afford a true index of the relative incidence of tuberculous and non-tuberculous cases appearing at the clinic. The records cover a period of about five years.

Owing to the hospital rule requiring diagnosis of all cases and transfer of histories to the record room very soon after discharge of patients, the probable diagnosis must frequently be entered on the histories before the pathological report has been received.

This affords us a clue to the incorrect clinical diagnoses in some cases (an indeterminable number), but clearly not in those which had received a pathological diagnosis before the discharge of the patient. Unfortunately a pre-operative diagnosis noted on the histories was usually lacking. With this explanation in mind, it is not without interest to note that 16 of the 35 cases of simple inflammation were found recorded as tuberculosis. Four other histories contained a recorded pre-operative diagnosis of tuberculosis; and 1 case was thought to be neoplasm of the testicle. That 20 of these 35 cases of simple inflammation were classed as tuberculosis emphasizes a need of more diagnostic information. Either the clinical or the pathological diagnosis was in error. For our present purposes, we accept the accuracy of the pathological diagnosis.

But the converse error in classification was not made. Cases which were pathologically tuberculous were properly classified, with but one exception. This man had been grouped with the syphilis cases because of a 4-plus Wassermann; but material removed from a sinus (supposedly a broken-down gumma) showed histologically definite tuberculosis.

Realizing the fallability of clinical opinion, we have, as stated, considered only cases bearing a microscopic diagnosis. Moreover, the group has been further confined by including only those cases with microscopic sections available in the pathological laboratory at the present time. The specimens examined consist of testicle, epididymis and vas only, as no operations on the prostate or seminal vesicles have been done for tuberculosis on the Urological Service at Bellevue Hospital. Doctor Douglas Symmers, the Director of Laboratories of this hospital, very kindly offered to go over all this material with me. In this review of sections from over 115 patients, he differed with the original verdict in only 2 cases, rendering his opinion in each instance without knowledge of the history or of the previous report. Because of this re-study of sections, two doubtful diagnoses were changed to "tuberculosis." Doctor Symmers pointed out that while most of the specimens could be definitely diagnosed by examining enough sections, at times the pathologist could not

decide between tuberculosis and syphilis, or between syphilis and simple chronic productive inflammation. Such indefinite reports were rendered in 4 cases, which were excluded from this study.

Comparing the series of tuberculous with that of simple inflammation of the epididymis—74 and 35 cases respectively—all of the patients complained of pain or swelling of the inguinal region, the scrotum or the scrotal contents. Urinary symptoms were added by 7 of the tuberculous group and 4 of the other group.

Over 25 per cent (19) of the tuberculous cases presented involvement of both epididymes on admission, while but 11 per cent (4) of the simple inflammatory cases had double epididymitis. Stating this in another way, about 83 per cent of the double epididymitis cases were tuberculous; whereas but 68 per cent of all cases considered in this report, were tuberculous. A more striking difference was seen in the fact that over 12 per cent (9) of the tuberculous cases had had a previous epididymectomy or orchidectomy, while not a single patient with non-tuberculous epididymitis had had a similar scrotal operation. This may mean that the infectious process causing simple non-tuberculous epididymitis is short-lived after epididymectomy, and hence does not involve the remaining epididymis months later as tuberculous inflammation so commonly does. This idea is further borne out by the behavior of the accompanying prostatic and vesicle infections which are yet to be considered.

A discharging sinus was present in 38 per cent (28) of the tuberculous and 6 per cent (2) of the non-tuberculous cases; the tuberculous sinuses had existed for varying periods of time up to nine years (and nearly one half for at least a month), while neither of the two simple inflammatory sinuses had been present over two weeks.

The age at onset offers no help in differential diagnosis; 40+ per cent of the tuberculous and 42+ per cent of the non-tuberculous cases were under thirty years of age. The fourth and fifth decades were represented by 36+ per cent and 12+ per cent in the tuberculous, and 27+ per cent and 21+ per cent in the

simple inflammatory groups; while 12+ per cent of the tuberculous and 9+ per cent of the non-tuberculous were fifty years or over at the time of onset.

Approximately 10 per cent of each of the two groups dated the onset of trouble from some trauma.

Thirty nine per cent (29) of the tuberculous and 62 per cent (22) of the non-tuberculous cases gave a history of Neisser infection in the past. Of the former, 3 were within two years and 1 within one year of the date of admission; of the latter, 6 were within two years and 2 within one year. (In 1 of these 2, the swollen testicle antedated the gonorrhea by six months.) However, while 8 of the tuberculous cases had had previous epididymitis (7 stated to have been with gonorrhea) on the involved side, but 4 of the simple inflammatory cases gave a history of earlier involvement of the affected epididymis. Our figures are admittedly small, but it would appear that a prior gonorrheal epididymitis has no influence on the character of a subsequent non-gonorrheal inflammation of the same epididymis.

Evidences of tuberculosis elsewhere were found in the tuberculous group as follows: bones, three times; lungs, ten times; glands, twice; previous epididymectomy or orchidectomy, nine times; previous nephrectomy, twice; renal tuberculosis proved during stay in hospital, six times (from cystoscopy done on 17 patients with pus in the urine). Among the cases of simple inflammation of the epididymis, there was but one with evidence of tuberculosis, and in this one the epididymitis occurred four months after nephrectomy for proved tuberculosis. Another very instructive case (not included in either of the two groups here reported) was a man twenty-eight years old who was admitted complaining of a painful swollen testicle of one month's duration. Epididymectomy on the other side had been performed three years before. The routine history noted frequency of urination. Pus and tubercle bacilli were found in the urine, and renal tuberculosis proved by ureteral catheterization. We supposed of course that the scrotal condition was tuberculous. The patient died following nephrectomy, and at autopsy tuberculosis was found in the remaining kidney and elsewhere. But the inflammatory condi-

tion in the scrotum proved to be a non-tuberculous abscess of the testicle; the epididymis was normal. It was noted that the seminal vesicle corresponding to this affected testicle was normal, whereas the vesicle on the side of the earlier epididymectomy was sclerotic and showed no active tuberculosis.

It is of some interest to compare the duration of epididymal disease (according to history), in the two groups of cases. In 69 of the tuberculous and all (35) of the simple inflammatory groups, the time of onset was given. The duration of scrotal symptoms was less than two weeks in 20 per cent (14) of the tuberculous and

TABLE 1

Findings on rectal examinations (62) of tuberculous epididymitis cases

DURATION OF EPIDIDYMAL DISEASE	NUMBER OF CASES WITH RECTAL EXAMINATION	NUMBER OF EPIDIDYMES INVOLVED	PROSTATE INVOLVED	INVOLVEMENT OF VESICLE CORRESPONDING TO DISEASED EPIDIDYMES	INVOLVEMENT OF EITHER VESICLE	INVOLVEMENT OF NEITHER VESICLE	ANY INVOLVEMENT ON RECTAL PALPATION
Under one month	16	17	11	11	12	3	13
One to three months	18	21	12	12	13	3	16
Three to six months	14	17	11	8	10	3	14
Over six months	11	16	6	8	8	3	9
Not stated	3	3	2	2	2	1	3
Totals	62	74	42	41	45	13	55

37 per cent (13) of the non-tuberculous cases. The duration was less than one month in 25 per cent (17) of the tuberculous and 48 per cent (17) of the non-tuberculous cases. In the one to three months period, the figures were 29 per cent (20) and 11 per cent (4) for the tuberculous and non-tuberculous cases respectively. In the period of three to six months, and in that of over six months, the relative percentages were nearly identical. Adding these two period, and considering all cases that had lasted six months or longer, the tuberculous group showed 46 per cent (32) while the non-tuberculous group had 40 per cent (14). Each group presented 4 cases of swelling of the epididymis of over three years standing.

Thus far, the data relative to the genital system has concerned only the scrotal contents, the almost invariable site of the complaint. To indicate the involvement of prostate and seminal vesicles, tables of all cases having notes on rectal examination are appended. From these tables details are easily read, but the cases are not numerous enough to warrant emphasis on any but general deductions. It suffices to call attention here to the observation that early cases (under one month) of tuberculous and non-tuberculous epididymitis have about an equal extent of involvement of the prostate and vesicles. As time elapses, these organs in tuberculosis continue to give palpable evidence of

TABLE 2

Findings on rectal examinations (32) of simple inflammatory epididymitis cases

DURATION OF EPIDIDYMAL DISEASE	NUMBER OF CASES WITH RECTAL EXAMINATION	NUMBER OF EPIDIDYMES INVOLVED	PROSTATE INVOLVED	INVOLVEMENT OF VESICLE CORRESPONDING TO DISEASED EPIDIDYMES	INVOLVEMENT OF EITHER VESICLE	INVOLVEMENT OF NEITHER VESICLE	ANY INVOLVEMENT ON RECTAL PALPATION
Under one month	16	16	6	8	9	7	11
One to three months	3	4	0	1	1	2	1
Three to six months	8	9	3	4	4	4	5
Over six months	5	7	1	0	0	4	1
Totals	32	36	10	13	14	17	18

disease in about the same proportion of instances as is found in the earlier cases; whereas in simple inflammation they tend gradually to become normal on palpation. Hence *marked* involvement of the prostate and seminal vesicles after epididymitis has existed over a month, is evidence in favor of tuberculosis; after six months it becomes a very strong argument for this diagnosis.

We have thought at times that various special conditions of the vas deferens as felt in the upper scrotum, offered a guide in differentiating tuberculous from other inflammations of the genital organs, but the statistical facts of the cases that have been operated upon do not bear out these particular suppositions.

A uniformly and markedly enlarged vas we thought favored a diagnosis of non-tuberculous inflammation. However, there were but 2 such found in this non-tuberculous group, and 3 in the tuberculous group. But this bit of evidence may be misleading, as all unoperated cases have been purposely omitted from consideration at this time, and the proportion of non-tuberculous cases in the group of unoperated epididymis is probably very high. An examination of a series of cases diagnosed *clinically* as non-tuberculous, but not operated upon and not used in this study, revealed 24 with notes on the vas deferens. Nine of these were slightly enlarged and 5 *much* enlarged. This side-light is suggestive, but I wish to avoid confusing information derived from cases bearing a clinical diagnosis only, with that gained from those cases diagnosed by the pathologist.

A beaded vas was regarded as indicative of tuberculosis. But while such a condition was noted in 7 tuberculous cases, it was also present in 3 non-tuberculous. Marked involvement at the lower end (near the testicle) occurred in the same proportion in the two groups. Large nodules, 2 cm. or more in diameter, were noted along the vas in 2 tuberculous cases and 1 non-tuberculous.

Some enlargement of the vas in at least a part of its accessible length was found associated with corresponding epididymitis in about 50 per cent of both tuberculous and non-tuberculous cases of less than one month's duration. But quite a striking difference in the two groups was noted in later cases. Considering those of over a month's duration, some involvement of the vas was recorded in but 27 per cent (18) of 67 tuberculous cases with notes on the vas, and in 68 per cent (15) of 22 non-tuberculous ones. But considering the total cases of over a month's duration presenting this enlargement of the vas, over half were tuberculous; hence no great help in diagnosis is derived from this observation. In the series reported, no instance was found of any enlargement of the vas deferens without involvement of the corresponding epididymis.

Bacteriological examinations were too infrequent to warrant comment.

A small but confusing group was composed of 4 cases of syphilis that had been operated upon—3 orchidectomies and 1 double epididymectomy. The specimens were histologically syphilitic. Three cases gave positive Wassermanns (probably reported after operation); the other had no blood test recorded. Two had scrotal sinuses, for one and three months respectively, suggesting tuberculosis. But all of these 4 patients had rectal examinations with normal findings. They all gave a history of a painless, gradually increasing enlargement of the testicles, beginning from five to twelve months before admission.

CONCLUSIONS

From this study, the following considerations would seem to be of value in the differentiation of tuberculous from the non-tuberculous cases of non-gonorrheal, non-luetic epididymitis:

1. Double epididymitis found on examination, slightly favors a diagnosis of tuberculosis.
2. A prior orchidectomy or epididymectomy almost invariably means tuberculosis.
3. A scrotal sinus of over a month's duration is probably tuberculous (but it may lead to a gumma).
4. Tuberculosis elsewhere in the body means genital tuberculosis in over 90 per cent of such cases.

In the diagnosis of cases presenting themselves within one month of the onset of epididymal swelling, we are dependent largely on the above general considerations.

In the diagnosis of cases of over one month's duration, we derive some help from the rectal examination. The older the lesion, the more does *definite* involvement of the prostate and vesicles point to tuberculosis; after six months, this becomes a very marked factor in favor of tuberculosis.

Finally, it must be emphasized that simple inflammatory changes of the epididymis may last as long as tuberculosis. There were four of the 35 non-tuberculous epididymitis cases who sought advice three years or more after onset of the swelling, and but four of the 74 tuberculous cases with a similarly long history.

TUBERCULOSIS OF THE ADENOMATOUS PROSTATE

J. DELLINGER BARNEY

Massachusetts General Hospital, Boston, Massachusetts

Received for publication August 10, 1922

Tuberculosis of the prostate, apart from that which is coincidental to epididymal tuberculosis, is a lesion of extreme rarity.

George Walker (1) has reviewed the literature with care and has excluded all but one or two of the reported examples of prostatic tuberculosis on the grounds of insufficient evidence. He says, "there remain still several autopsy records and possibly a few clinical reports which can be accepted, and these show that primary tuberculosis of the prostate does occur." None of the cases reviewed by Walker seem to be analogous to the one about to be decribed.

In a more recent review of the subject Koll (2) found "but 2 probable cases of primary tuberculosis of the prostate reported." His statement, with which I agree, that this "does not represent a true percentage of the primary invasion of the gland by the tubercle bacillus, but a deplorable failure on the part of surgeons to have careful histologic examinations made of their specimens" is possibly, even probably, accountable for the scarcity of such cases.

The 2 cases cited by Koll were apparently undoubted examples of tuberculosis of the prostate combined with adenoma. To these he adds 1 case of his own similar to mine in that the clinical history, physical examination and operative procedure differed in no detail from that of the ordinary adenomatous gland. The report of the pathologist alone drew attention to the rarity of the lesion. Because of the extreme infrequency of such cases

and also because it is possible that frequent and more careful histologic examination of specimens may reveal other instances I wish to record the following case.

G. A. C., railway mail clerk, aged fifty-seven years consulted me in October, 1921. There had been more or less irritability of the bladder for about a year, the symptoms being somewhat relieved by taking hexamethylenamin. In August, 1921, urination became very difficult and amounted almost to retention. There was moderate diuria (five to six), much nocturia (five to six), but no dysuria, urgency or hematuria. Retention gradually increased so that before consulting me he had been catheterized on three different occasions, about a pint of urine being removed each time. Catheterization gave a certain amount of relief each time. There had been no loss of weight or strength and no pain. There were no symptoms referable to the urinary tract other than those described.

Physical examination showed a well preserved and healthy looking man. Tongue moist and clean, chest negative, abdominal examination negative. Rectal examination showed considerable enlargement of the prostate, which did not appear to be malignant, nor was it tender, nodular or indurated. Epididymes showed a small amount of thickening throughout but patient recalled no acute lesion of these organs. Soft rubber catheter passed easily to the bladder withdrawing several ounces (residual) of hazy, acid urine with a specific gravity of 1018, no albumin or sugar, and with a moderate amount of pus in the sediment.

Suprapubic prostatectomy was done in two stages, the first operation on October 26, 1921, with novocain local anesthesia. At this time palpation of the bladder aspect of the prostate aroused the suspicion of possible malignancy as the gland felt rather more firm than is usual with adenomatous hypertrophy. The operation was completed November 1, 1921, under spinal anesthesia. During removal of the prostate it was found to be much enlarged, with areas of induration and adhesion here and there which seemed to confirm the suspicions of malignancy already alluded to.

Convalescence was uneventful in every way and the patient left the hospital with a tight wound, normal urination and no residual on November 12. A month or two later the patient lifted a heavy mail bag and soon after noticed a leakage of urine from the suprapubic scar. Examination at this time showed a pinpoint opening at the lower end of the wound, no residual and a urine which was practically

clear. Rectal examination showed only the usual smooth scar which follows prostatectomy. A short session in bed with an indwelling catheter closed the sinus and there has been no further trouble.

The interest in this case lies in the report of the pathologist, Dr. H. F. Hartwell.

There are two irregular, soft nodules, each about the size of a plum, with moist, grayish-white surfaces on section containing soft, pale yellowish areas.

Microscopic examination shows the structure of adenomatous hypertrophy with extensive wandering-cell infiltration. There are large areas of necrosis surrounded by epithelioid cells.

The specimen was unfortunately lost, thus preventing further study, but being desirous of confirming this report by another opinion, I submitted the single surviving paraffin section to Dr. F. B. Mallory who kindly made the following statement.

It [the section] shows a well marked, fairly chronic and typically tuberculous process, namely, miliary and conglomerate tubercles with giant cells and more or less extensive areas of necrosis surrounded by endothelial leucocytes with an occasional giant cell here and there. The process has invaded the lumina of the glands and ducts of the prostate in places and is extending along them. One focus of uninvolved gland tissue is of the hyperplastic type often seen in the nodules present in hypertrophied prostates, commonly but incorrectly spoken of as adenoma.

The interesting speculation now arises as to which process was primary, adenoma or tuberculosis. I incline to the view that the former lesion first appeared, for the reason that if tuberculosis was the primary offender it would have by its production of necrosis, caseation and deposition of fibrous tissue so destroyed the parenchymatous elements of the prostrate that adenoma could not have developed. There was no demonstrable tuberculous process in the lungs (x-ray of the chest might have revealed an old process) so that the origin of the process in the prostate is a question which cannot be decided. An interesting feature of the case, to which I invite special attention, is that tuberculosis of the

genital tract is primarily a disease of the young adult, the frequency with which it is found rapidly decreasing at and after middle life.

REFERENCES

(1) WALKER, GEORGE: Johns Hopkins Hospital Reports, xvi.
(2) KOLL: Annals of Surgery, October, 1915.

DISCUSSION

Dr. E. L. KEYES, JR., New York: Dr. Stevens' paper is founded on cases seen in our service in Bellevue. Our rule there is that the diagnosis of tuberculosis shall not be made upon a case of spontaneous epididymitis which is less than three months old unless there is active tuberculosis elsewhere in the genital or urinary tracts. Yet we do operate on a certain number of cases, as he has said, within the three months, period because their infection is so active that they require operation any way, whether tuberculous or not. Those that do get by are not assumed to be tuberculous until three months have elapsed. Therefore the number of non-tuberculous cases operated upon has been diminished, but in spite of this you will note the number of errors we have made in diagnosis. I am satisfied that this rule of not operating too hastily has saved a number of epididymes because a number of these look like tuberculosis to all of us and in the course of weeks subside, and though the epididymitis was marked, the process disappears so that only the smallest scar remains.

With reference to Dr. Barney's interesting description I would like to add 2 cases. One was seen at Bellevue when I was not present on service, and the gentleman seeing it in a middle aged negro, thought it a sarcoma of the prostate because it was a very large prostate in a young man. Consequently a total prostatectomy was done and the whole prostate removed. It proved to be tuberculous on pathological report, and the subsequent course bore out that finding for eighteen months. Although it did finally heal, no involvement of kidney or epididymis was seen. I have seen a second case two years ago. He has at no time shown any involvement except of his prostate in which the diagnosis of tuberculosis was suspected on account of the absence of gonorrhea and the hard, nodular perivesicular involvement and this certified by the finding of tubercle bacilli

in the secretion of the prostate and in the urine although the kidneys remained normal. This man has also a slight tuberculosis of the lung. I have recently heard by letter that he is relieved of his symptoms.

Dr. FRANCIS R. HAGNER, Washington: I think this paper of Dr. Stevens brings up many interesting points and is a very valuable contribution. We have had in the last two years several cases of epididymitis coming on without any history of infection except supposed attacks of influenza, and in some of these cases the nodules were quite hard and persisted for some time and finally cleared up. I think the Doctor spoke of these cases of tuberculous epididymitis as not being painful? [Dr. STEVENS: No, they are painful.] That has not been my experience. Most of the cases of tuberculous epididymitis have not been painful. They come on insidiously without pain. There is one type which has severe pain, and that is miliary tuberculosis, and that not only involves the epididymis but the testicle as well.

I think, probably all of us have at one time or another taken out a syphilitic testicle when we thought it was a tumor or a tuberculous condition. We should be very careful about this. I had a case which a colleague referred to me in which a diagnosis of gonorrheal epididymitis was made, an epididymotomy performed, the patient did not get well, so the testicle was removed and sent to me for my examination. It was found to be a gumma.

Another thing—unless it is a perfectly clear case of neoplasm or tuberculosis or infection we should not remove it without a Wassermann being done as the regeneration in gumma is truly remarkable under treatment.

This is a little out of the way of the subject—some years ago I had a man with gummata of both testicles in which each organ was at least one-half the size of a man's head. A diagnosis of syphilis was made. Following treatment the testicle got perfectly well and appeared absolutely normal on palpation. He married and now has five children. I have seen the children and they all look like the father, and I know the man has millions

of spermatozoa. It seems remarkable that such regeneration could take place and not have sterility.

Dr. JOHN R. CAULK, St. Louis: Dr. Stevens has shown us the features in differentiating the various types of epididymal lesions. I wish to add to this, a case I saw two years ago; a doctor who had an aching testicle for about two months, the swelling recurring, getting better and worse. When he came to me he had typical nodulation along the vas and epididymis; it looked to be classical tuberculosis. I thought he had surely a tuberculous epididymis and vas. In exploring the scrotum I found that there was a thrombosis of all the vascular supply, of the vas and epididymis. I was able to remove this chain without disturbance of circulation, and he got well; but it shows how puzzling these conditions are.

Dr. J. D. BARNEY, Boston: I was very much interested in Dr. Stevens' illuminating communication. I would like to add one or two observations which I have been making over a period of some years. Dr. Cabot will recall that some years ago we were all having a scrap over the diagnosis of a patient in the out patient department. It was finally suggested that the fluid be taken from the hydrocele for examination of the sediment. Tubercle bacilli were found in this fluid, and the diagnosis was clear. With that as a clue I thought we would be able to make a diagnosis more often by this means. I have been interested in removing the hydrocele fluid in several cases and examining it but I have not again found the tubercle bacillus and neither have I found the gonococcus except in one or two cases, so this method seems to offer very little hope. Then it occurred to me that chemistry might help us out. So I have been carrying out investigations on the difference between the chronic hydrocele and the acute hydrocele; whether tuberculous or non-tuberculous. The work is still under way and is not ready to be published. I might say that the chronic hydrocele fluid has shown one interesting feature, namely, that the fluid from the two sides is always the same and varies with

the chemistry of the blood. The chemistry of the acute type is different from that of the chronic hydrocele and does not seem to be different in two lesions, tuberculous and non-tuberculous. Therefore it does not appear that we shall be able to throw much light on the differential diagnosis. The work has not, however, gone far enough to permit of final conclusions being drawn.

There are 2 cases which I saw some time ago which illustrate the difficulties of making a diagnosis and the value of giving the patient the benefit of the doubt by operation. One was a young man who had every evidence of tuberculosis of the lung and whom I saw with one of my colleagues in Boston. He diagnosed tuberculous epididymitis (to which I agreed), took a conservative view and sent the patient to Saranac. Later a surgeon removed this testicle, and it proved to be sarcoma. I might say that the man is now dead from metastases.

Another case which occurred two or three years ago I saw in consultation with a surgeon who made the diagnosis of tuberculosis of the epididymis. I agreed with him and advised operation. The surgeon advised conservative treatment and did not operate. Another surgeon took the testicle out later, and it proved to be sarcoma. I was wrong in my diagnosis in these 2 cases, but entirely right in advising operation in a condition of the scrotum which is open to the least suspicion.

Dr. JAMES PEDERSEN, New York: Someone has said that tumors of the testicle are difficult to diagnosticate. Tuberculosis of the testicle seems to live up to the tradition. Dr. Barringer's recital of cases of tumor of the testicle, reminds me of a large sarcoma of the testicle I removed some years ago. The pre-operative diagnosis was later confirmed by the pathologist; but as the patient has had no sign of recurrence in all this time, I now doubt the diagnosis.

I agree with Dr. Hagner that pain is one of the diagnostic signs in tuberculosis. Given two cases of a sluggish inflammatory process in the epididymis, one that has pain and one that has not, the one with pain is to be regarded as tuberculosis.

Dr. A. R. STEVENS, New York: The things that stand out prominently from this study are the great difficulties of diagnosis in the first month and the help derived from rectal examination after the first six months. The tuberculous cases had the same frequency of involvement of vesicles or prostate after six months as they had in the first month, whereas the non-tuberculous cases showed normal vesicles and prostate six months after onset of epididymitis.

As regards pain, I do not think pain is much of a help. We had many cases that proved to be tuberculous come in with great tenderness in the involved part.

We found that we had operated on 4 syphilitic cases. Three of them had positive Wassermanns, but those reports came in a week after the cases had been disposed of. However, the syphilitic cases all bore this in common—they were all of them painless and had had a very slow, gradual development; and in these cases the patient had noted involvement for at least five months. I was personally very much disappointed in the beaded vas. I had felt that if the vas had a distinct beaded feeling, it would point to tuberculosis; but we found this in the non-tuberculous and the tuberculous cases to the same proportion. Of course, in this work (as Dr. Keyes has pointed out) we have considered only a certain group, the group that had the diagnosis made in the laboratory, believing the pathological diagnosis more reliable than the clinical.

PHARMACODYNAMIC REACTIONS OF ERECTILE TISSUE AND THE DORSALIS PENIS ARTERY

DAVID I. MACHT

Pharmacological Laboratory and Brady Urological Clinic, Johns Hopkins University

The physiology and even the anatomy of erectile tissue has never been satisfactorily investigated and our knowledge on the subject is still very meager. In connection with a pharmacological investigation of aphrodisiac drugs the author thought it desirable to inquire into the pharmacological behavior of erectile tissue as well as of the dorsalis penis artery. After long experimentation a method of studying these tissues has been developed and the effects of various drugs on the same were investigated. In the present research isolated surviving pieces of corpora cavernosa and spongiosa were kept alive in warm oxygenated Locke solution under special conditions and the response of the preparations to various drugs was studied. In the case of the dorsalis penis artery, rings of the dog's artery were employed.

The modern anatomist in tracing the finer structure of the nervous system resorts to pharmacodynamic reactions for the determination of the origin of different parts of the sympathetic nervous system. Thus for instance a pharmacological response to adrenalin is an indication that the particular muscle preparation studied is innervated by the true or thoracico-lumbar sympathetic system; while a response to such drugs as pilocarpin and atropin indicate an innervation coming from the parasympathetic or bulbo-sacral sympathetic system.

In the present investigation it was found that both erectile tissue preparations and preparations of the dorsalis penis artery responded with contraction or relaxation as the case might be on treatment with epinephrin and ergotoxin. On the other hand numerous experiments made with pilocarpin, physostigmin, atropin and other so-called "parasympathetic" poisons failed to

elicit any response in either the erectile tissue or dorsalis penis artery preparations. In view of these results, repeatedly and consistently obtained, it appears that both corpora cavernosa and spongiosa as well as the dorsalis penis artery of the dog are supplied by nerve filaments belonging to the true sympathetic system and not by the parasympathetic system.

SECOND DAY, MAY 2, 1922

REPORT OF A CASE OF SCHISTOSOMUM HEMATOBIUM

JAMES PEDERSEN

New York

Received for publication August 10, 1922

The patient. a boy seventeen years old, was born in Africa. When three years old he came to the United States with his parents. The family returned to South Africa a year or two later and lived there until the boy was ten years old, at which time they again took up their residence here.

For seven years, i.e., ever since his second stay in South Africa, the boy had had intermittent hematuria. The degree had varied considerably; clots had occasionally been seen recently. There had been no disturbance of the bladder function and no pain, at any time. The patient had had no symptom except hematuria. We found him well developed for his age; neither inconvenienced nor alarmed by the hematuria. He had grown up with it.

The cystoscopic examination showed several small areas of a dull red color; they looked like hemorrhagic blotches, slightly raised above the surface of the mucous membrane. More or less surrounding these areas, irregularly scattered, were small elevated points, like vesicles (fig. 1).

The picture suggested tuberculosis, though the absence of both pain and frequency of urination made that diagnosis impossible. The Wassermann test was reported positive 2+ by one laboratory; negative by two, five days later. Repeated

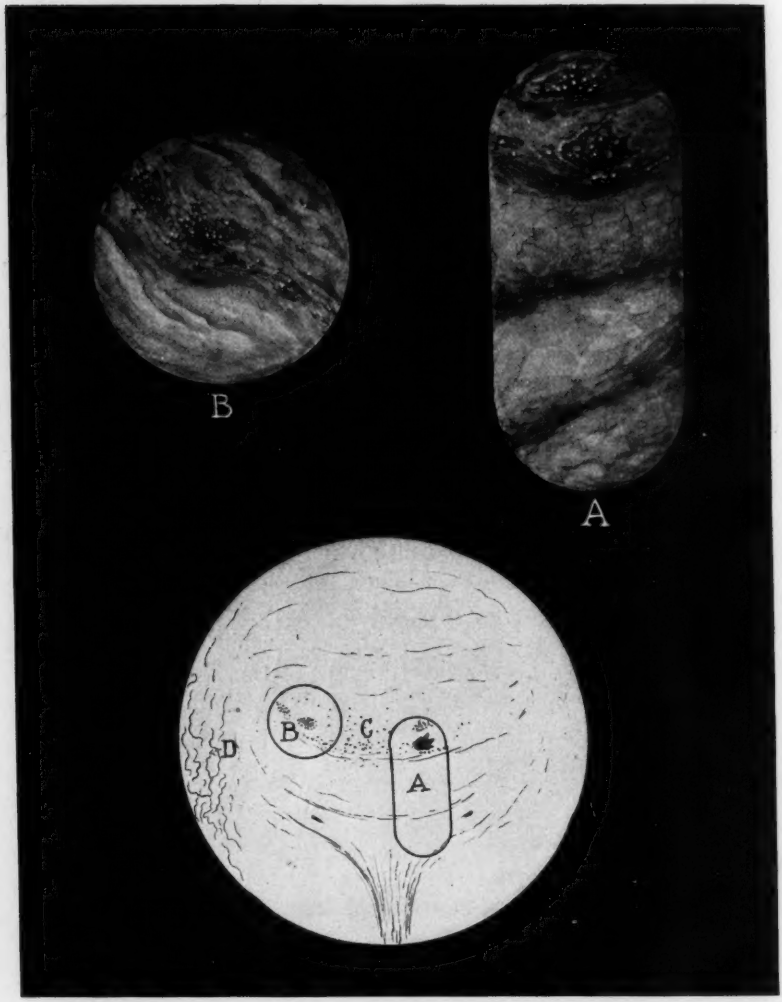


FIG. 1. The cystoscopic view of the lesions is shown in the drawings A and B. Their respective location in the bladder is indicated in the diagram. At C were scattered vesicles. At D a roughening of the mucous membrane.

examinations of the urine proved the absence of tubercle bacilli; but there were marked traces of albumen, occasional red cells, a few single leucocytes, a normal amount of mucous and an object which was identified as the ovum of the Schistosomum hematobium. These ova were fairly numerous. A few were found in the feces.

FIG. 2. MICROPHOTOGRAPH OF AN OVUM

The regulation treatment was given—a normal salt solution of tartar emetic intravenously every other day for a period of three weeks, during which time he was kept in the hospital. Thereafter he was treated every third or fourth day in the office and allowed to return home. The commencing dose was 0.5 grain; the maximum reached was 2.75 grains.

The only reaction was a very transient nausea until on one occasion during the office course, when the maximum dose (2.75 grams) was given and repeated two days later. Marked nausea and depression, embarrassed respiration and slowing of

the pulse to 60 promptly occurred. After resting for nearly three hours, he was able to go home comfortably.

The patient received in all 25 injections over a period of two months and a half. The ova began to disappear with the twelfth injection. None had been found for a month before he went away to college. A specimen of urine submitted six weeks after treatment had been necessarily stopped, was equally free from them. Eight months have elapsed and no relapse has been noted.

Cases of this disease are rare in our climate. In October, 1918, Dr. McCarthy and Dr. Maximilian Stern reported a case from the Urologic Service at the Post Graduate Hospital. The patient had contracted the disease in Egypt while working in an irrigating ditch. He developed hematuria very soon after exposure, and hurriedly returned to the United States. The cystoscope showed clusters of whitish pinhead elevations with a red areola. Some of these elevations were more prominent and spheroidal as if about to rupture. On the posterior wall there were carinoma-like formations, ragged and red; one, which was pedunculated, was spherical in shape and the size of a hazel nut.

The trifling symptoms and lesions in the seventeen year old boy with a seven year history when contrasted with the symptoms and grosser lesions in the older subject whose history was brief, naturally raise three questions: (1) as to the influence of age; (2) as to a variation in the virulence of the organism; (3) as to whether bilharziosis is a factor in vesical new growths.

On questions (1) and (2) we may speculate. On (3) we have this interesting testimony in the literature. Ferguson (Journal of Pathology and Bacteriology, 1911) discussing bilharziosis associated with primary malignant disease of the bladder, reports 40 cases of that description examined by him during his six years in Cairo. All were male subjects whose ages averaged forty-two. The outstanding points are these: (1) At least 40 per cent of all males over five years of age in the agricultural population in Egypt, have bilharziosis (urinary bilharziosis).

(2) Malignant disease of the male bladder is more common in Egypt than in any other country. (3) Malignancy of the anus, rectum, sigmoid and colon is remarkably rare considering the fact that those parts are equally infected by the parasite.

Of the 40 cases (all came to autopsy), 34 proved to be flat cell epithelioma; the remaining 6 were carcoma.

Ward, a Zoölogist, writing in Wood's Handbook, describes three varieties of the schistosomum which produce severe disease in man, and notes that they have been more or less confused.

Only one produces bladder lesions, namely, the Schistosomum hematobium. It is native, apparently, only in Africa and the contiguous parts of Asia; it occurs elsewhere only when imported. The parasite, however introduced, gains the portal vein and works against the current until it lays its eggs in narrow venules in the submucosa of the bladder, thus blocking the venules. It is not known how the ova escape from the veins of the submucosa to form the bladder lesions.

Ova or embryos may be carried along in the current of these small venules, reach the vena cava and get into the general circulation. Their distribution is then very like that of the tubercle bacillus—lungs, liver, peritoneum, etc.

When the ova escape into the mucosa of the bladder from the submucous venules, they cause inflammation and swelling of the mucosa, followed sometimes by hypertrophy and the deposition of mineral matter, thus giving rise to hard, circular areas and sandy patches. Phosphatic stone may result. Stone develops in 80 per cent of Egyptian cases, the ova forming the nucleus. Papillomata occur, variable in size, often occupying a large surface.

Pain is felt in the lumbar region and blood and pus are expelled with the urine in these advanced cases. The symptoms progress in severity. The disease, known by the generic name bilharziosis, is persistent and may last six, eight or more years. If the patient is continually exposed to infection, successive exacerbations occur.

The second form, the schistosomum of Manson, has a different geographical distribution; it is common in the West Indies and

South America and sometimes occurs in our southern states. It is found, of course, in Egypt and other parts of Africa. By itself it does not produce bladder lesions, but when associated with the Schistosomum hematobium, causes a severe form of bilharziosis.

The third or Japanese form of schistosoma, indigenous in Eastern Asia, is the cause of a serious and often fatal form of disease; but spares the bladder. The Public Health Service is alert to keep it out of the United States.

The mistake of grouping the diseases set up by these trematode parasites under the term "bilharziosis" is responsible for much confusion. The term bilharziosis should be restricted to the variety that attacks the bladder. Of this, there are two clinical forms, one is medical and curable by emetine and antimony; the other is surgical throughout. The medical type is simple bilharzial hematuria, the so-called uninfected type with plenty of ova in the urine. Physicians who report these cases never use the cystoscope so that no one knows whether lesions are present in the bladder or not. The vesical symptom is irritability. The cure may be temporary or there may be only a spontaneous intermission. These cases may or may not become infected and border on a surgical form. It is evident that the purely surgical case with its multiple tumors and infection is not amenable to drugs; but whether this is a separate variety from the start, or a later stage of the medical case, does not seem to be clear.

Pavy (Medical Journal of Australia, August 27, 1921) reports 10 cases treated only with intravenous injections of tartar emetic. The average total amount given was 27 grains during the course of from seven to eight weeks. The ova disappeared from the urine in from three to four weeks. The toxic symptoms were cough, nausea and vomiting. In fact, a paroxysmal cough seems to have occurred regularly, beginning a minute after the puncture and lasting five minutes. There was also pain and stiffness of the arm and shoulder muscles for some hours after the injection. Loss of appetite and consequent loss of weight together with general malaise were noted. Like Casper, he puts pyuria and hematuria on a par in the symptomatology.

DISCUSSION

Dr. Wm. C. Quinby, Boston: I should like to mention in connection with Dr. Pedersen's very splendid paper 3 instances of this disease which we have happened to see in the Brigham Hospital. Two occurred in boys, the sons of an English teacher who had been teaching in a public school in South Africa. They were boys of about fourteen and thirteen years of age. They had had their hematuria without any other special symptoms for a matter of two or three years each. Those cases, I am told, responded splendidly to the treatment you have outlined—to antimony compounds given intravenously.

Apparently the disease is very common in South Africa, so common that in the cases of boys of less educated families there is a tradition that a boy has not reached manhood until he has urinated blood.

A third case occurred in a Scotchman who had been in the service of the British army during the Boer war. This case was seen two or three years ago, but his symptoms had persisted from the time of the Boer war up to the present. They were, however, due to the formation of calculus, a group of calculi being found in a dilated, distorted ureter, the result of chronic Bilharzia disease of the urinary tract. His bladder showed a few areas such as your illustrations demonstrate, the effect of long-lasting infection with the parasite; and one of these when removed by a small cystoscopic rongeur showed definite ova. We could not find ova in the urine. Dr. George Shattuck after his Serbian experience has started a clinic for tropical diseases in Boston, and we referred this case to him. I do not know the outcome, but he was planning to treat the patient with some form of intravenous antimony.

Dr. Hugh Cabot, Ann Arbor, Mich: There is a quasi public health aspect of this question. There are now coming to this

country in larger numbers than ever before students from South Africa. For instance, in Michigan we have more than 200 such students. Now a great many of those people have this disease, and it has been entirely overlooked. I think that those of us who are in contact with students or engaged in industrial work should make an effort to round up these people. They have had this disease and regard it as an act of God. I have seen 5 cases and started to round them up. The first case I saw had much pain in the right side and had developed pyonephrosis as a result of contraction of a scar at the orifice of a ureter. He was not paying any attention to the fact that he had scars in his bladder or hematuria but this pain in his side was bothering him. I think we ought to make an effort to investigate all students from South Africa for the presence of this disease.

Dr. R. F. O'NEIL, Boston: I am very much interested in Dr. Pedersen's report. I reported a case of this disease in 1904, which was one of the earliest cases reported in this country. The man was a soldier who had served in Africa in the Boer War. He presented the typical terminal hematuria. The cystoscopic appearances were similar to those described by Dr. Pedersen. The examination of the urinary sediment showed the presence of the typical ova with the sharp spine at one end. He was treated by injections of atoxyl, this being before the days of the use of tartar emetic. I had him under observation for some months, and whether in spite of, or because of, this treatment, the symptoms disappeared, the ova disappeared from the sediment and he made, apparently, a good recovery. Since that time we have had an occasional case at the Massachusetts General Hospital. As I understand, this disease is not of any particular danger to the community, as the parasite is transmitted through an intermediate host, by means of infected drinking water or infected food. The disease is very common in South Africa, much more so in men and boys than in women. This is accounted for by the fact that the boys and men bathe frequently in the infected rivers and streams, thereby swallowing a certain amount of water.

The cystoscopic appearances are typical and combined with the finding of the ova in the urine make the diagnosis of this condition easy.

Dr. WILLIAM F. BRAASCH, Rochester, Minn.: I would like to report a case of Bilharzia which we have observed. The patient served in the Boer War, and since then had had intermittent hematuria over a period of five years. He had been treated by various men in different countries without relief. Cystoscopic examination revealed a definite ulcerated area of granulating tissue which we at first thought was a malignant tumor. However, the diagnostic ova were found, and the microscopic section of tissue removed did not show malignancy. Fulguration was tried, but without success. Finally we resected an ulcerated area with the surrounding granulating tissue which covered an area of about 2.5 cm. by 5 cm. The patient recovered uneventfully following the operation. We kept in touch with him for two or three years, during which time he was quite well.

Occasionally, on account of the deep ulceration, these cases become surgical in spite of treatment. The intervention of malignancy has also been reported in these ulcerative conditions.

Dr. JAMES PEDERSEN, New York: I have nothing further to add. It is evident that the disease is already increasing in this country, and while I agree with what Dr. Quinby said, I should like to reiterate the point to which Dr. Cabot called attention, the necessity of being on the lookout for this disease for sanitary and public health reasons.

RENAL COUNTERBALANCE[1]

AN EXPERIMENTAL AND CLINICAL STUDY WITH REFERENCE TO THE SIGNIFICANCE OF DISUSE ATROPHY

FRANK HINMAN

From the Urological Department of the University of California Medical School and Hooper Foundation for Medical Research, San Francisco

I. INTRODUCTION

Modern writers accept too readily the occurrence of compensatory hypertrophy of the kidney. Evidently its observation has been so long general as no longer to attract notice or comment. At any rate its true significance and importance, particularly in relation to the surgery of the kidney, has been almost entirely overlooked. Twenty years ago the subject was kept very much alive by the many wordy battles of the cellular pathologists, with some creditable experimental work, as to renal hypertrophy versus renal regeneration. Apparently the complete victory of the former has left the subject flat and without interest. The remarkable advance in renal diagnosis and renal surgery since then calls for a revival of interest and study, but with an entirely different viewpoint.

The problem of the choice of the better or best operative procedure in the treatment of many renal conditions is still difficult in spite of improvement in the methods of diagnosis and in surgical technic. Mistakes are by no means as frequent or at all comparable to those made before the common use of the cystoscope and ureteral catheterization. But occasionally any surgeon practising in the field of the urinary tract will meet with an unlooked-for result, both in the way of success as well as of failure, and in the case of failure will wish when it is too late that in place of being

conservative he had been radical, or vice versa. Some of these surprises can be attributed to technical errors, some to compensatory hypertrophy, but many of them cannot be so easily explained. It is in this latter group that a reconsideration of renal compensation is particularly pertinent.

It is the purpose of this paper to present a study of some experimental and clinical examples of renal compensation with this surgical aspect particularly in mind. Heretofore renal reserve and compensatory hypertrophy have been the sole factors recognized. We shall endeavor to show that renal competition and disuse atrophy are factors that must be reckoned with in the counterbalance that follows many surgical procedures on the kidney, and renal disease without surgery as well.

II. HISTORICAL REVIEW

A. Observation of compensatory hypertrophy

Rayer (1) in his remarkable book gives, as early as 1841, as good a clinical description of compensatory hypertrophy as has appeared. Various aspects of the subject have been since discussed, notably by Albarran (2, 3, 4), Anzilotti (5), Bizzozero (6), Carnot (7, 8), Cohnheim (9), Eckardt (10), Fiori (11, 12), Galeotti (13), Ghoreyeb (14), Morel and Verliac (15), Peruzzi (16, 17), Pisenti (18), Pousson (19, 20), Podwyssozki (21), Ribbert (22, 23, 24, 25, 26, 27), Simon (28), Sacerdotti (29, 30), Stoerk (31), Tuffier (33, 34), Virchow (35), and Wossidlo (36). Four types of renal hypertrophy have been observed:

1. Unilateral or mass hypertrophy. The hypertrophy of a healthy kidney in compensation for the loss of function on account of disease in the opposite side is a well known fact. The kidney is often remarkably increased in size but preserves its form and normal appearance (Rayer, 1). Some interesting observations have been made with respect to the pathological process leading to destruction of the other kidney. In the renal destruction by hydronephrotic atrophy, following a complete ureteral block, hypertrophy of the opposite kidney is perfect and comparable to that which follows experimental nephrectomy (Albarran,

2, 3). In aseptic lithiasis the hypertrophy may be slight and the enlarged kidney often presents sclerotic zones resulting from a "diasthenic nephritis." With such diseases as pyonephrosis, renal tuberculosis and cancer there may be no compensatory hypertrophy of the good kidney on account of an inhibition (Albarran, 2). It cannot therefore be said that hypertrophy is always proportional to the amount of kidney destruction.

The recognition of hypertrophy of the remaining kidney after nephrectomy has been universal and was known long before nephrectomy was a surgical practice, from the results of experimental production in animals. The experimental work of Simon (28) on 30 dogs before he undertook to do the first nephrectomy on man is classical. This hypertrophy, however, is not a complete anatomical compensation or substitution, as will be shown later (paragraph B).

2. Circumscribed hypertrophy. The hypertrophy of isolated areas in a diseased kidney has been frequently observed. Destructive processes, with a few exceptions of diffuse lesions, do not affect the whole renal parenchyma simultaneously. The unaffected areas may show considerable hypertrophy (Rayer, 1). There is group injury with group compensation. The parts of the kidney spared by the disease take the place of those which succumb (Albarran, 2). Trauma, tumor, infarction, infectious nephritis, stone, retention, may all distribute their action unevenly in the different renal lobes of the same kidney.

In studying chemical nephritis many investigators have found also that all parts of the kidney do not participate to the same degree and that after a time compensatory hypertrophy of the more healthy parts occurs (Chauffard, 37; Golgi, 38; Nauwerck, 39, 40). Charcot and Gombault (41) describe islands of injury and islands of hypertrophy in nephritis, and many histologic studies of small granular kidneys (Köster, 42; Weber, 43; Ziegler, 44), of interstitial nephritis (Fortlage, 45; Golgi, 38; Ribbert, 22, 27), and of parenchymatous nephritis (Golgi, 38; Albarran, 2) point to a definite attempt to shunt the renal function to a small, less injured portion of the renal parenchyma. Thorel (46) describes compensatory hypertrophy of uninjured

renal tissue in cases of infarction, which Albarran (2) finds in every way analogous to that seen in partial resections. Ribbert (27) noted in the kidney of a syphilitic infant areas atrophied by interstitial nephritis and areas showing compensatory hypertrophy.

3. Bilateral hypertrophy. The increased functional activity in very chronic severe diabetes has been supposed to lead to an hypertrophy of both kidneys (Rayer, 1; Albarran, 2; Pousson, 19; Sacerdotti, 29). Fletcher, in Osler's Modern Medicine, says they are often enlarged but does not attribute this enlargement to hypertrophy. Curiously, degenerative changes affect Henle's loop only. That the kidneys are enlarged and congested in diabetes insipidis has often been observed also. Of much more interest and significance is the fact that Sacerdotti (29) has produced bilateral hypertrophy experimentally by transfusing the blood of several doubly nephrectomized dogs into a second dog previously bled. Emge (47), however, failed to find renal hypertrophy in rabbits fed on large quantities of urea, and Carnot (8) reports 20 cc. of urine fed daily inhibits hypertrophy.

4. Renal anomalies. The enlarged kidneys found with congenital anomalies form an analogy in renal compensation which is more apparent than real. Congenital absence or agenesis of one kidney occurs about once in 2650 cases (Piersol, 48). Secher (49) quotes statistics compiled by Scheur and Sternberg, which show that in 119,055 autopsies collected from the literature by them there was one case of absence of one kidney in every 5953 cases. Scheur and Sternberg themselves presented seven cases of absence of one kidney, collected from their group of 81,500 autopsies. In those reports which give careful measurements it is shown that the solitary kidney equals in size and weight that of two normal kidneys for an individual of similar age and size (Rayer, 1; Abel, 50; Lyon, 51; Moore, 52; Clark, 53; and Radasch, 54; who collected 255 cases in 1908), whereas the compensatory hypertrophy that follows unilateral destruction, nephrectomy for instance, never doubles the renal mass. The solitary kidney is not, therefore, a true analogy. In its embryonic development a normal amount of renal tissue, even though uni-

lateral, has been provided. In the case of the congenitally small or infantile kidney, which is accompanied by a large pardner, the total renal substance again equals that of two normal kidneys. There is hypoplasia on one side and hyperplasia on the other (Gruber and Bing, 55). Apparently in these instances of congenital enlargement, or hyperplasia, the renal reserve has not been used up to the same degree as in the hypertrophy of true compensation. The substitution is embryologic and not compensatory.

A number of curious instances of unilateral hypertrophy of the whole body have come to autopsy. Gordinier (56) finds 28 cases reported in the literature up to 1918. In some of these cases the kidney of the hypertrophied side has been noted as being much larger than its mate (Hutchinson, 57), but in Gordinier's (56) personal case no disparity in the size of the kidneys was found. The difference in the size of such kidneys would presumably be due to circulatory conditions and not to compensatory factors anyway.

B. The time required for the production of hypertrophy

1. As estimated by measurement of the kidney. Most of the estimations of the increase in size of a kidney have followed experimental nephrectomy. Morel and Verliac (15) determined the respective and total weight of the two kidneys in a series of white rats as a control. In another series they performed left nephrectomy and after varying periods of four to fifty days sacrificed the animal and got the weight of the remaining hypertrophied kidney. In the "first phase," four to ten days, the kidney increased 32 to 37 per cent in weight; in the "second phase," ten to twenty days, 9 to 16 per cent; and in the "third phase," twenty to fifty days, 11 to 16 per cent. The early greater enlargement they attributed to hyperemia. Carnot (8) found the opposite kidney of the rabbit enlarged on an average of 33 per cent (16 to 53 per cent) fourteen days after nephrectomy. Paolo Fiori (11) and Tuffier (33) estimated, independently, that twenty to twenty-five days are required for the anatomical completion of a compensatory hypertrophy after

nephrectomy, and in this time one-fifth to one-sixth of the original kidney weight is replaced. Carnot (8) attempted to modify the regular course of hypertrophy by physical, chemical and physiological agents. X-ray caused occasionally a considerable increase (an 88 per cent increase in five days in 1 case), an average increase of 50 per cent, or double. Theobromine, lactose and cantharides gave very variable results. Urine in amounts of 20 cc. per day inhibited the course of hypertrophy (0 to 3.8 per cent and 2.4 per cent), but extracts of kidney, fetus, thyroid and hypophysis promoted its development (respectively, 33 to 39 per cent; 55 to 60 per cent; 50 to 53 per cent; 32 per cent, to 44 per cent, and 48 to 61 per cent). Nigst (58) found that a complete enervation of a kidney failed to influence the development of hypertrophy in rabbits.

2. As estimated by study of the renal function. We can find only a few careful studies of functional repair after nephrectomy. The native reserve power of a healthy kidney is generally regarded as sufficient to care for function after nephrectomy. Pilcher (1913) reduced the kidney substance by ligating branches of the renal arteries. He states that loss of one-half renal blood supply, by ligating one branch of both renal arteries, does not cause any noticeable disturbance in renal function as measured by urea nitrogen excretion, which remained practically normal even with reduction of kidney substance to one-fourth. Karsner, Bunker and Grabfield (60) (1915) followed the non-protein nitrogen of the blood after reduction of kidney substance and found a distinct increase lasting for three days only, and that removal of two-thirds of kidney substance did not prevent the excretion of urine in normal amounts and concentration. Rowntree and Geraghty (61) estimated that two to three weeks are required after unilateral nephrectomy for phenolsulphonephthalein to be excreted as normally by two healthy kidneys. By following the fluid and chemical constituents of the urine Fiori (11) estimated that ten days are required for complete restoration of function. André Weill, however, using Ambard's constant, estimated that it took two months in dogs for the remaining kidney to take over the work of two kidneys. He had

previously fed his dogs on meat until the urea concentration in the urine had become maximum and constant, so that in his experiments the reserve kidney had to compensate for a distinct overload. Ribbert (26) observed that it took "several days" after nephrectomy for the remaining kidney to be able to excrete indigo-go-carmine in the same time as in normal animals and that in old animals the remaining kidney never did become able to excrete all of the dye stuff in the normal time period. Wossidlo (36), also with the aid of indigo-carmine, finds that about six weeks are required for a return to a normal equilibrium after nephrectomy.

C. Histologic studies of hypertrophy

1. The progressive changes of hypertrophy. In reviewing the literature of this section it is well to keep in mind the complexity of renal structure, a few of the striking instances of which may be profitably mentioned. The blood supply to the kidney is unique. In amount it is truly enormous. In distribution it has no parallel. It may vary in amount nineteen times as much as the average supply to other organs. In their distribution the capillaries terminate in glomeruli under high pressure and then empty into a second capillary bed. And most striking of all, there are apparently few primary nutrient blood vessels in the kidney. Doubling the activity of such an organ must have a tremendous circulatory effect. No less significant in this connection is the fact that full embryonic development of the organ is delayed for from two to six years after birth, as evidenced by the persistence up to this time of embryonic glomeruli (Councilman, 63).

It is not surprising then that the early effect of increased function overwhelms the circulatory system. Seventy-four hours after nephrectomy there is an intense congestion, and even diapedetic infiltration of the interstitial tissues. The epithelium lining glomeruli and tubules swells and the cells multiply by mitosis to the point of filling the tubular lumina and give rise upon desquamation to the formation of cylinders or casts. This process shows group distribution in that it does not reach the

same severity in all areas. The acute hyperemia gradually subsides (four to ten days—Morel and Verliac, 15), leaving the glomeruli and tubules in places enormously dilated and fringed often with very large epithelial cells (Golgi, 38; Eckhardt, 10; Rosenstein, 64; Van der Stricht, 65; Albarran, 2; Sacerdotti, 29). The initial change is in every way analogous to an acute interstitial nephritis (Pousson, 19). In the second stage there is a gradual increase in the size of glomeruli and tubules. The epithelium becomes very much hypertrophied, and the convoluted tubular elements particularly are enlarged with respect to the thickness of their walls and the size of their lumina. Glomeruli also may grow to be two to three times their normal volume and are structurally perfect (Albarran, 3). These hypertrophic changes again show first a group distribution, which gradually spreads uniformly throughout the kidney.

2. Hypertrophy vs. regeneration or hyperplasia. It will hardly be necessary more than to summarize the literature of this paragraph, even though it forms the bulk of that available on compensatory hypertrophy.

The question of an actual formation of new glomeruli and tubules was under debate for many years. Material used for study was so various as to render conclusions difficult of conciliation. New formation of both glomeruli (Lorenz, 66) and tubules (Ribbert, 23) was observed in young animals, but Councilman (63) states that embryonic elements may persist even in man up to the sixth year. The remarkable mitosis which is present in areas of parenchymatous and interstitial nephritis has led to misinterpretation, many workers believing it a sign of true regeneration. Thus Lipsky (67) observed new formation of epithelium after inflammation, and Albarran (3) explains this finding as nothing more than connective tissue granulation. Simpson (68) studied 81 small kidneys of patients eighteen months to seventy-one years of age and in 5 found fairly large sized fields of pure buds. These new tubules are usually lumenless and contain two to five cells on transverse section. Sprouting of buds from preëxisting tubules was also observed. In these same kidneys elongation and widening of the tubules was noted.

Stoerk (31) had previously described similar conditions in hypernephroma as methods of new formation of renal parenchyma. Before 1900 Petrone (69), Pisenti (18), Kummel (70), Tizzoni and Pisenti (71), Tuffier (34), Vogel (72), and Tillmans (73) had expressed a belief in renal regeneration, but during the same period disbelief in it was voiced by Aschoff (74), Anzilotti (5), Ballowitz (75), Barth (76), Beckmann (77), Beumer (78), Bizzozero (6), Cohnheim (9), Enderlen (79), Eckhardt (10), Falk (80), Fiori (11), Golgi (81, 82), Gudden (32), Guttmann (83), Grawitz and Israel (84), Oliver (85), Köster (42), Lancereaux (86), Leichtenstern (87), Loeb (88), Lorenz (66), Lustig and Galeotti (89), Galeotti and Villa-Santa (13), Maas (90), Wolf (91), Nauwerck (39), Nothnagel (92), Podwyssozki (21), Perl (93), Peruzzi (16, 17), Ribbert (23), Rosenstein (64), Simon (28), Stoss (94), Thorel (46), Valentin (95), and Weigert (96). Since 1900 no one has found true renal hyperplasia. Recently Berti (97) has studied the question from a slightly different angle in man, concluding also that new formation does not occur. As Councilman says, the kidney has a marked capacity for repair but, except in the very young, none for true regeneration of tissue. Epithelial cells may show regeneration of new cells and the compensatory hypertrophy of healthy portions may simulate new formation, but a true regeneration of renal parenchyma does not occur.

3. Repair in hydronephrosis. The anatomical and functional restoration of a hydronephrotic kidney following relief of the ureteral obstruction is most interesting. It was in the course of an experimental study of repair in hydronephrosis in white rats that the relationship of repair to counterbalance, which has been the incentive for the present contribution, was first appreciated. Work in experimental hydronephrosis (Johnson, 98; Donati, 99, 100; Hinman, 101) shows that a kidney which has had a complete obstruction of its ureter for two weeks or less may not only regain normal function but be capable also of undergoing a complete compensatory hypertrophy after opposite nephrectomy. We were further able to show with white rats (Jour. Urol., 1919, 174) that "the effect of relief of back pressure

on hydronephrosis of twenty-one to sixty days is shrinking in size with preservation of kidney shape and the grouping of all tubular remnants in one relatively large median sagittal lobule;" that "the tubular and glomerular elements of the central lobule show definite hypertrophic changes;" that "in hydronephrosis of ninety-five days or longer no such central lobule is noticeable;" that "the central lobule developed after relief of obstruction in hydronephrosis up to sixty days shows many hypertrophic convoluted tubules which stain intensely by the intravital method;" that "new formation of tubules cannot be demonstrated;" that "the recovery and hypertrophy of already markedly atrophic structures and their renewed susceptibility, or even hypersusceptibility, to intravital staining is evidence of the ability of hydronephrotic kidneys up to certain stages (sixty days) to undergo considerable anatomic and functional restoration;" and that "in hydronephrosis of ninety-five days or longer recovery, either anatomic or functional, of the secretory elements cannot be demonstrated." We registered our impression in this same article (pp. 150, 153 and 154) of the unfairness of these experiments, as well as those of Johnson (98), Donati (99, 100) and others, to the hydronephrotic kidney; in the one instance by requiring it immediately to do double duty by removal of the opposite kidney, and in the other (pp. 152 and 153) by placing it in unequal competition with the thoroughly capable compensatory kidney when nephrectomy is not performed.

The clinical importance of the above experimental facts is quite evident and the two following statements rob it of none of its significance: "Plastic operations on a large hydronephrosis of a capacity of more than 5 or 6 ounces is usually unsuccessful," (Braasch, 102), and "The possibility of restoration of function upon relief of obstruction is long past when the kidney can be palpated. The damage produced in a fully developed hydronephrosis is permanant." (Walker, 103.) No doubt both Drs. Braasch and Walker in making the above statements presume that the opposite kidney is perfectly healthy.

D. The amount of renal parenchyma necessary for life

The same general conclusion that about one-third of the combined weight of two kidneys is required to maintain life has been independently reached by many different experimental investigators. De Paoli (104), in 1892, by resection of part of a kidney and nephrectomy on the other side, found that an animal could live on one-half of one kidney. Paolo Fiori (11) (1901) by similar experiments estimated the amount of kidney substance necessary to support life as one-twelfth to one-fifteenth per kilo of the body weight of the animal. Castaigne (105) (1902) determined that one-third to one-fourth of the combined kidney weight is necessary for life. Vitzou (106) obtained a similar result. Mauchle (107) (1894) had reached the same general result after nephrectomy on one side and ligature of several of the smaller branches of the opposite renal artery; and Pilcher (59) (1913) reduced the kidney substance also by ligature of branches of the renal artery to one-fourth and found that the urine remained normal in quantity. Tuffier (33) found 1.5 grams of kidney substance per kilo sufficient to maintain life, and found an increase in weight by hypertrophy of that remaining to 100 per cent, which Broca (108), however, claims is no argument against regeneration and accuses Tuffier of a mathematical error. Rose-Bradford (109) noted death in one to six weeks after removal of three-fourths of the renal substance, and this finding has been confirmed by Bainbridge and Beddard (110). Pearce (111), by allowing compensatory hypertrophy to occur after the removal of half of a kidney, was then able to remove still more, sometimes as much as three-fourths of the total kidney substance in dogs, without change in the nitrogen metabolism; and he found that after the second resection there was an increase in the hypertrophy of the secretory elements over the hypertrophy already produced by the first resection. More recently Karsner, Bunker and Grabfield (60) (1915) have been able to reduce the renal mass by two-thirds without affecting the normal amount and concentration of urine excretion. Schwarz (112) comes to the conclusion that there is a relative proportion between the excretory power and the mass of excreting parenchyma. How-

ever, Bonardi (113) concludes from an experimental study that nephrectomy notably diminishes the animal's resistance to infection and poisons; and Giordano (114) and Ollive and Le-Meigneu (115) even go so far as to estimate the diminution in working value of a man with one kidney as 50 per cent.

E. The question of biologic changes due to nephrotoxins

Lindemann (116) (1900) claimed that he could produce a substance in the serum of guinea pigs specifically toxic for the kidney of a rabbit by injecting an emulsion of rabbit's kidney into guinea pigs; that this "nephrotoxin" in the serum of the guinea pig would not only produce albuminuria but also death by uremia in three to five days after intravenous injection in the rabbit, and that the rabbit's kidneys presented necrosis of the epithelium of the convoluted tubules resembling that from renal poisons. This finding was confirmed by Nefedieff (117) (1901), Bernard and Meissner (118), and Castaigne and Rathery (105, 119, 120) (1902), the latter of whom have most vigorously championed the idea. Paolo Fiori (11, 12) (1903) noted a difference in the histologic appearance of the opposite kidney after ureteral ligature and after nephrectomy and attributed the more pronounced trophic alterations in the case of ligature as due to abnormal products in the circulation. Amos (121) (1905) reports the unbelievable finding of death in rabbits in every instance after simple ureteral ligature under conditions suggesting uremic coma, and attributes death as due "presumably" to the absorption of toxic substances still being secreted by the ligatured kidney. Hirsch and Mascke (122) (1912) allowed a nephrectomized dog to become uremic when its carotid was connected to the jugular of a healthy dog, the kidneys of which as a result showed on examination marked changes in their epithelium. Albarran and Bernard (4) (1903), Pearce (123) (1904) and many others have not been able to confirm these findings and deny the existence of specific nephrotoxins, cytotoxins, etc. The experimental work of Rosenow, while not directly related to the kidney, renders attractive the idea of the specific nature of tissue proteins. This subject is by no means satisfactorily closed.

F. Renal atrophy

The small infantile kidney, already referred to (II, *A*, 4) is not an atrophied kidney. The parenchyma of such a kidney and the products of its activity are normal. They are abnormal quantitatively only. Geraghty and Plaggemeyer (124) (1913) found 3 of this type among 36 cases of renal atrophy in 3940 autopsies, and they pointed out their true diagnostic and surgical importance. Simpson (68) (1915) classified contracted kidney into five groups:

(1) Genuine or primarily contracted kidney.

(2) Athero-sclerotic kidney (patchy sclerosis—Zeigler).

(3) Secondary contracted kidney (chronic interstitial nephritis).

(4) Hydronephrotic contracted kidney (Aschoff).

(5) Senile kidney.

All of these forms are retrogressive metamorphoses and when bilateral may be explained as the result of degenerations (albuminous, fatty, hyalin and amyloid) or necroses, due to the destructive action of bacterial or mineral toxins or the products of disordered metabolism. Occasionally nephritis is unilateral, and several writers (Babouneix, Braasch) have drawn attention to the atrophic condition of many of these unilateral types. In line with the main argument of this paper it occurs to the writer that this atrophy is largely the result of, or is, at least, hastened in its progress by, diminution or loss of function on account of the increased ability of the opposite healthy kidney. In all of Braasch's 28 cases of "atrophic pyelonephritis" total function was normal indicating that the opposite kidney had undergone complete compensatory hypertrophy.

Pathologists (Adami, 125) "recognize that the two prime factors which tell upon the health of the individual cells are nutrition and the performance of function." Excess as well as lack of nourishment, or excess as well as lack of function, may lead to atrophy. Disuse atrophy is of common knowledge for many organs and structure, but so far as our search of the literature goes we can find not a single reference to disuse atrophy of the kidney. Nutritional atrophy as we understand it for other

organs is also difficult of application to the kidney, because, with the exception of a few to the pelvis and capsule, the kidney probably possesses no true nutrient arteries. Nutrition and function in the kidney are almost synonymous. Lack of function means poor nourishment, and a rich or excess of nourishment is not possible without an increase of function. The work of a kidney is therefore an important factor for either hypertrophy or atrophy.

G. Summary of historical review

The body has normally a relative amount of renal tissue. A large individual will have large kidneys and a small individual, small kidneys. If in development one kidney only is formed it will equal the weight of what two normal kidneys would. If in development one large and one small (infantile) kidney are formed the two together will equal the weight of two normal ones. If there is destruction of renal tissue by disease, trauma or operation, that part remaining uninjured or the least injured will attempt to take over the lost function. For this counterbalance nature has provided a certain reserve, but this native reserve is quite limited and unable to carry for any length of time any sort of an added burden. Renal tissue meets this demand, if at all continued, by growth, by compensatory hypertrophy. According to the nature and portions of injury this compensatory growth may be a unilateral mass hypertrophy or a circumscribed group hypertrophy. It requires a period of time for its completion and is roughly proportional to the functional demand. Doubling the demand never results in doubling of the renal mass by hypertrophy. But the demand may be so great as to overwhelm the tissue and an actual atrophy from excess of function results, whereas, if the demand is gradually increased a much greater burden eventually will easily be borne. Renal reserve therefore is potential and not actual and is measured by the degree of hypertrophy that is possible. Regeneration of renal tissue does not occur in response to an increased functional demand except in the very young. The degree of hypertrophy possible is very great. One-third (one-fourth under conditions

of gradual reduction) of the normal renal mass may so hypertrophy as to counterbalance the loss of the other two-thirds (or three-quarters). There is no mention in the literature of renal atrophy from loss of function as a factor in renal counterbalance.

III. EXPERIMENTAL STUDY[2]

A. Introduction

The problem of renal counterbalance is complicated and made more interesting by the division of the renal mass into two equal and separate portions. This anatomical partition has been long regarded by surgeons as a blessing but may often prove to be misleading. It establishes an obvious competitive basis for renal compensation. Injury more frequently affects one portion, and competition between this and the remainder is thus rendered unequal. We may take economics of industry in point of illustration. The renal mass and renal function may be said to represent an equilibrium respectively of supply and demand. The demand, or the total renal work required, shows general variations only, such as occur with the growth of an individual and the normal fluctuations of excretion following changes in diet and exercise. But the supply, or the total renal tissue that performs the required work, may show marked alterations. Usually these changes are those of loss or insufficiency as a result of disease, trauma or operation. But occasionally the change may result in a surplus of renal mass or supply, as, for example, after the removal of ureteral stones or after repair operations in hydronephrosis. The process of a reëstablishment of an equilibrium of supply and demand that follows these alterations in the supply or demand is the process of renal counterbalance. Injury from disease, trauma, etc., or surgery are responsible for the anatomical alteration by which tissues are thrown out of

[2] The writer wishes to express his appreciation and great indebtedness for the generous assistance in many of the following animal experiments of Dr. A. E. Belt, fellow in Hooper Research Foundation 1919–1922, and Resident Urologist of the University Hospital, 1921–1922. No less commendable has been his zealous interest in searching the medical literature, and whatever of completeness there is in the bibliography is due largely to his invaluable assistance.

balance, and the establishment of a final anatomical counterbalance may take years for its completion, even though compensation of function is effected within a few days. In the establishment of such an anatomical counterbalance we believe that, first, compensatory hypertrophy as a result of the action of increased functional activity upon renal reserve, and, second, disuse atrophy as a result of loss or diminished functional activity through an unequal competition with the above are important factors.

One can think of numerous animal experiments to test the correctness of these statements regarding renal counterbalance. Such experiments were begun by us in 1916. The results have all been confirmed by at least three, and in some cases eight, repetitions. Some of the experiments require a period of about two years for their completion, and this being realized beforehand, three to four animals were run together. After the completion of the initial experiment the result was often so striking as to lead to the necessity of a control experiment of like duration.

The relationship of reserve power and of competition to renal compensation will appear more logically if dealt with separately.

B. Renal reserve and compensatory hypertrophy

1. As observed anatomically. The simplest experiment that will test renal counterbalance is nephrectomy. A healthy kidney is thus suddenly burdened with just double the work to which it is accustomed. We wish to express our indebtedness to Dr. Thomas Addis for permission to mention his very interesting, unpublished results in this connection. He finds differences in the degree of hypertrophy of different portions of the renal tubule. In rabbits, one to three months after nephrectomy, the glomeruli have increased 20 per cent in size over those of the removed kidney, the collecting tubules 7 per cent, while the proximal convoluted tubules have increased 60 per cent. The average total increase was 70 per cent. Complete ligature of one ureter accomplishes as effectively as nephrectomy the development of a compensatory hypertrophy. We have been able to study over 400 hypertrophic rat kidneys after complete liga-

ture of the opposite ureter for periods of one to six hundred or more days' duration. The hypertrophic changes as measured by an increase in the size of the kidney were complete on an average of twenty to thirty days. There was no demonstrable increase in size beyond this period, even of those kidneys doing double duty for almost two years. In no case was the size of the kidney doubled nor did the increase ever even approach to this degree. In figure 1 is shown a series of hypertrophic rat kidneys typical of the different periods, and in table 1 the measurements are summarized. It is seen that the average total increase is 20 per cent of the normal.

TABLE 1

Measurements of hypertrophied right kidneys in rats after total ligation of left ureter

DURATION OF HYPERTROPHY	AVERAGE KIDNEY MEASUREMENTS			NUMBER OF RATS REPRESENTED	AVERAGE WEIGHT OF RATS
	Length	Width	Depth		
	cm.	*cm.*	*cm.*		*gms.*
None; normal	1.63	0.90	1.01	30	194
4 days	1.63	0.90	1.03	7	192
8 days	1.87	0.93	1.03	10	196
14 days	1.90	0.96	1.05	21	201
28 days	1.90	0.92	1.09	20	193
42 days	1.95	0.99	1.15	17	197
56 days	2.00	0.97	1.12	14	195

Hypertrophic kidneys of rabbits, cats, dogs and pigs after opposite ureteral ligature have also been studied, but in relatively small series. The findings correspond to those for rats. Doubling of renal tissue by hypertrophy has never been observed.

The histologic changes of compensatory hypertrophy vary with the period of examination. There are three distinct stages: First, the initial congestion, second, the active mitosis and growth, and third, the final equilibrium of hypertrophy. It is difficult to understand how there can be increased functional activity during the initial hyperemia that overwhelms a kidney with the sudden demand for more work. The picture closely resembles an acute inflammation with diapedesis, swelling and leukocytic infiltration. That there is an increase of function shows

how dependent renal activity is upon blood volume, which must be enormously increased. During the second stage the pronounced karyiokinesis of cells is apparently an attempt to repair the acute damage and to meet the new demand by hypertrophy. The complete hypertrophy of the third stage

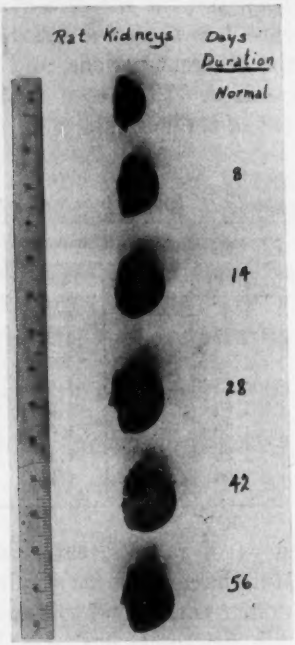


FIG. 1. Photograph (¾ size) of the hypertrophic kidney of rats of similar weight and age at varying periods after opposite complete ureteral ligature. The kidneys of twenty-eight, forty-two and fifty-six days are practically all of the same size.

is proportional in a way to the demand. Hypertrophy is a relative term and a cell may grow slightly or double or treble its original size, and apparently the size it attains is dependent up to a certain limit upon the degree and progressive character of the strain to which it is subjected. In figure 2 is shown a micro-

photograph of a normal rat kidney stained intravitam with diamin blue, and in figure 3 a hydronephrotic repair hypertrophy. The difference in the size of these convoluted tubules is quite obvious. Both rats weighed approximately the same, 200 grams.

2. As observed functionally. The usual clinical supposition is that the native reserve power of a healthy kidney is sufficient

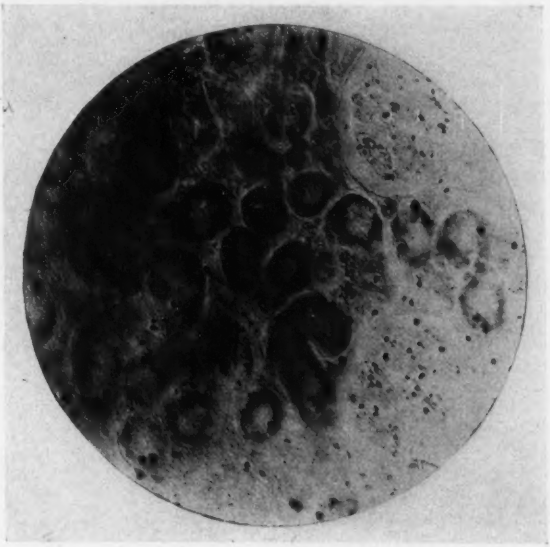


FIG. 2. Microphotograph (high power) of normal rat kidney stained intravitally. The convoluted tubules only take the stain. Compare with figure 5, a hypertrophic rat kidney similarly stained and magnified.

to do double the amount of work on demand. The number of individuals who have weathered nephrectomy with no functional disturbance of any kind is its warranty. So far as ordinary tests go, such as the amount and concentration of the urine, blood nitrogen and phenolsulphonephthalein output, the remaining kidney is just about equal to the task. But if the least overload is put on this kidney its insufficiency is at once apparent.

Kutzmann,[3] in collaboration, has made carefully controlled and definite experiments in dogs to test this point. He finds that in the first two to three days after nephrectomy the excretion of urea and phthalein are definitely diminished and there is a corresponding rise of urea and non-protein nitrogen in the blood. A graphic chart of his findings is reproduced in figure 4. Phthalein

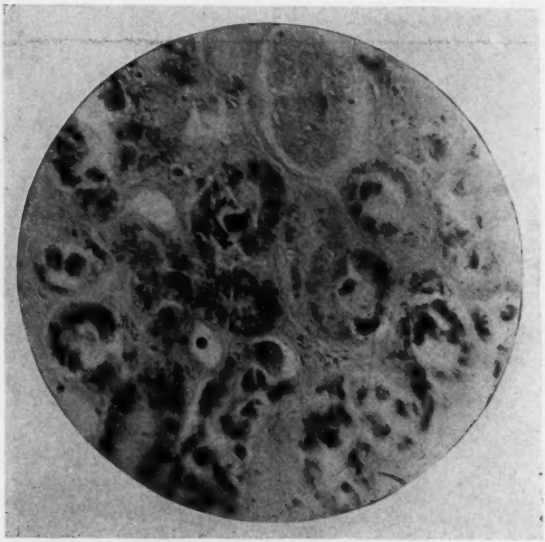


FIG. 3. Microphotograph (high power) of a hypertrophic repair nodule (middle specimen of figure 5) stained intravitally, which shows more intense staining and greater hypertrophy even than that of a complete compensatory hypertrophy, and a remarkable hypertrophy as compared to the normal of figure 2, magnified similarly.

is normal by the third or fourth day but urea excretion not until about the tenth or eleventh day. Putting the kidney under a greater strain by injecting urea prolongs the period of unbalance. A control experiment with dogs under ether for one hour, but

[3] This work has not been completed for publication and I wish to thank Dr. H. A. R. Kutzmann, surgical interne, University Hospital for his courtesy in allowing me to publish this part of it.

without operation, gave no similar alteration in the phthalein or in the blood and urine nitrogen. Goldschmidt and Pearce have shown that splenectomy has no effect on renal function, so that it seems fair to rule out shock from operation or anesthesia as a

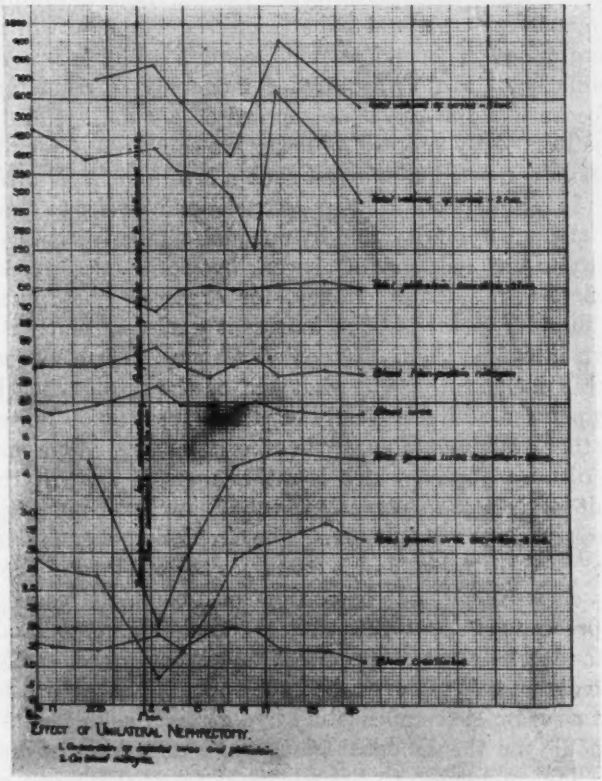


FIG. 4. The rise in blood nitrogen and fall in nitrogen and phthalein secretion shows definite incapacity of the reserve of one kidney to care for the loss of function of a kidney during the first few days after nephrectomy.

contributing factor; and a just conclusion is that the native reserve of a kidney is insufficient to take care of as much as 50 per cent increase in work, and that this additional demand through increase of function leads to hypertrophy.

C. Renal competition and disuse atrophy

It has been shown that in the case of normal kidneys upon the removal of one the remaining kidney is at first unable to do the work of both and that it becomes competent to do so only after it has developed an hypertrophy. The questions naturally arise: When such an unilateral hypertrophy is complete, will it form a more or less independent renal system? Will it prove to be self-sufficient? Has it acquired a monopoly of renal function, and because of this can it now crowd off the market all inferior competitors? By surgical measures we can place different renal masses in competition and test such a law of survival of the fittest. It is understood that by competition we refer to quality of work and not quantity, and by unequal competition we do not refer to an unequal amount of work but to its relative ease and efficiency. An infantile kidney, for example, does much less work than its partner, but so long as it works efficiently it holds its own in competition. A repair hydronephrosis also does less work but inefficiently, and what will be the result when placed in competition with a perfectly capable hypertrophic mate?

Another experimental example other than repair hydronephrosis of disuse atrophy, which is rather unusual and bizarre and difficult of certain explanation, will follow transplantation of one ureter into the duodenum. The circulation of such a kidney has not been disturbed and it continues to get blood of the same quality as its fellow, but on account of a complete reabsorption of its products of activity its work is completely wasted and lost. In so far as a help to the opposite kidney is concerned, it might as well be completely removed, and the opposite kidney will undergo just as complete compensatory hypertrophy as if it had. But why should not the duodenal-transplant kidney likewise undergo a complete compensatory hypertrophy? And if it does, will it continue indefinitely to do double duty uselessly? These two sets of experiments will be presented separately.

1. Experimental hydronephrosis. The competitive factor in renal counterbalance and the subsequent disuse atrophy of renal tissue can be illustrated by comparison of the results that follow four types of experiments with hydronephrosis:

a. The early result of ureterocystoneostomy in hydronephrosis, when the opposite kidney is undisturbed.

b. The late result of ureterocystoneostomy in hydronephrosis, when the opposite kidney is undisturbed.

c. The result of ureterocystoneostomy in hydronephrosis, with opposite nephrectomy.

d. The result of ureterocystoneostomy in hydronephrosis, when the work of the opposite kidney is gradually destroyed by a partial ureteral obstruction.

a. The early repair in hydronephrosis upon relief of ureteral obstruction by transplantation into the bladder. In the repair

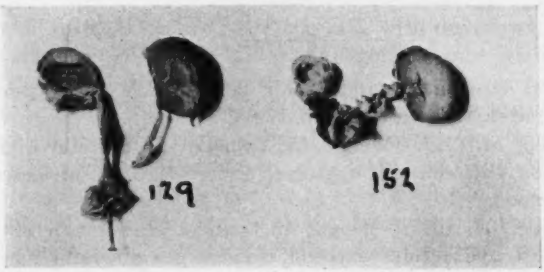


FIG. 5. Photograph ($\frac{3}{4}$ size) of two hydronephrotic repair kidneys with their respective hypertrophic mates. There is a median-sagittal or central repair nodule present in each. A microphotograph of the first specimen, sixty-day complete ureteral obstruction with one hundred and twenty-nine-day repair period after ureterocystoneostomy, is shown in figure 3.

experiments on white rats, even with sixty days' complete obstruction, it was found that considerable repair occurred after relief of the obstruction by hydroureteral transplantation. This repair was evidenced by the formation of a secretory nodule, which was proportionally greater in the short periods of obstruction than in the long periods, but the repair period in all of these experiments was only from thirty to sixty days; that is, it was within thirty to sixty days of the ureterocystoneostomy that the rat was sacrificed (fig. 5). The two points in question are: Would these repair nodules appear differently if the period of competition with the compensatory kidney on the

opposite side were prolonged, and would they also appear differently if the competition were equalized by a concurrent injury on the compensatory side?

The following two protocols are of dogs with left ureteral obstruction of forty-four and sixty days and a repair period of unequal competition with the opposite hypertrophic kidney of forty-three and fifty-five days, respectively, and are reported in full in order to show the destructive result of severe renal infection. The experimental results are often difficult of interpretation because of the complicating action of infection or imperfect urinary drainage, and we wish the reader fully to understand our appreciation of this difficulty.

Protocol 1

Ureteral obstruction and repair period each of forty-four days. Long-haired sky terrier, male, no. 17-63.

November 14, 1917. Weight 15¾ pounds. Left ureter divided near the bladder between silk ligatures, under ether. Convalescence and recovery good.

December 28, 1917. Weight 16 pounds. Ether narcosis; surgical asepsis; left hydroureter exposed, divided just above ligature; incomplete emptying of sac by compression of 38 cc. of dirty, brownish fluid, showing microscopically enormous numbers of blood and pus cells. Hydroureter transplanted to bladder.

January 7, 1918. Convalescence has been good. Dog active. Phthalein 60 per cent in two hours.

February 9, 1918. Weight 16½ pounds. Ether, right ureter exposed, doubly ligated near the bladder and divided between the ligatures.

February 11, 1918. Death; acute hemorrhagic nephritis of right kidney with localized peritonitis. There had probably been bilateral infection so that upon ligature of the right ureter the hypertrophied kidney was unequal to the additional strain. Blood vessels at infected foci ruptured and a marked retro-peritoneal and intracapsular hemorrhage resulted, with extravasation of urine and spread of infection to the peritoneum. The pelvis of the left kidney is contracted. The minor calyces are formed of thickened fibrous bands and the atrophic cortex shows diffuse pyelonephritis.

Protocol 2

Ureteral obstruction of sixty days, repair period of fifty-five days. Long-haired grey dog, no. 17-66, weight 22 pounds.

November 16, 1917. Ether; double ligature and division of left ureter near bladder.

December 28, 1917. Slight attack of distemper.

January 16, 1918. Weight 23 pounds. Left ureter transplanted to bladder. By compression 117 cc. of dark, dirty fluid aspirated.

February 26, 1918. Weight 23½ pounds. Right ureter transplanted to duodenum. 1 cc. phthalein intravenously; none obtained through bladder.

February 27, 1918. Bladder; faint trace of phthalein in two hours; 40 cc. urine.

March 13, 1918. Dog has been very sick with distemper. Phthalein, faint trace in two hours. 210 cc. of slightly cloudy, watery urine.

March 15, 1918. Death from distemper. Duodenal transplant in healthy condition. Right ureter is patent but some obstruction is present, as evidenced by slight ureteral dilatation. Duodenum is not inflamed. Left kidney is shrunken, very blue and flabby. The left ureteral transplant to the bladder is in very good condition and the bladder is filled with light cloudy fluid. Upon section the kidney is seen to have two well developed repair zones of renal parenchyma, one at either pole. The remainder is a thick structureless sac wall with radiating fibrous bands carrying blood vessels (fig. 6-2).

Comment. The above two experiments illustrate the destructive action upon the renal parenchyma of a pronounced infection and are reported in order to dispel any probable inference of our failure to recognize infection and injury as important factors in producing a late atrophy. We have been able to show, however, that in spite of infection or injury from back pressure, renal parenchyma placed under different circumstances does not atrophy (see types c and d), and on the other hand, that while they may hasten it, neither can be regarded as the sole factor in producing some types of what may be looked upon as examples of disuse atrophy.

b. The late changes that follow relief of obstruction in hydronephrosis where the opposite compensatory kidney is healthy and undisturbed. We have tested the above question of competition

by keeping our animals for long periods after ureterocystoneostomy before sacrificing them. In all of the animals in which a competition had been active for one year or longer a very considerable to total atrophy of the hydronephrotic repair kidney is found. The forty-five-day hydronephrosis of dog 17–56 after four hundred forty-three days' competition has completely atrophied (fig. 6, *3*), in spite of an increased demand during the last sixty-nine days on account of an imperfect uretero-rectal transplant of the compensatory kidney. Dog 17–13 (fig. 6, *1*) is interesting from the standpoint of repair after partial obstruction. At the end of six months of partial left ureteral obstruction by means of a rubber band, when the left pelvic capacity was 895 cc., the large tortuous hydroureter was transplanted into the bladder; seven months later there is one small hypertrophic repair nodule at the lower pole of a remarkably shrunken kidney. Microscopic section shows persistence of functionating renal radicals in the nodule and the presence still of atrophic glomeruli in the rim where all tubular elements are missing. The following 4 protocols are examples of late atrophy.

Protocol 3

Ureteral obstruction of thirty days, repair period of two hundred and ninety-seven days. 48-pound dog, no. 17-179.

June 28, 1917. Ligature and division of left ureter.

July 28, 1917. Left hydroureter transplanted to the bladder.

November 17, 1917. Total phthalein, 83 per cent.

May 28, 1918. Right nephrectomy. Blood urea, 18.64 mgm. per 100 cc.

May 30, 1918. No phthalein in one hour, ten minutes.

June 1, 1918. Blood urea, 86.7 mgm. per 100 cc.

June 5, 1918. Blood urea, 354.2 mgm. per 100 cc. Dog not eating; listless. Temperature 34.6°. Sacrificed. Left kidney is small and atrophic but with two zones of repair tissue at either pole similar to the kidney in 17-66. But these repair nodules were unequal to the task of total renal function after the removal of the completely hypertrophied right kidney and the dog would have died in a very short time of uremia. This experiment is of interest and most significant when compared to the final result in dog 20, protocol 8, in which

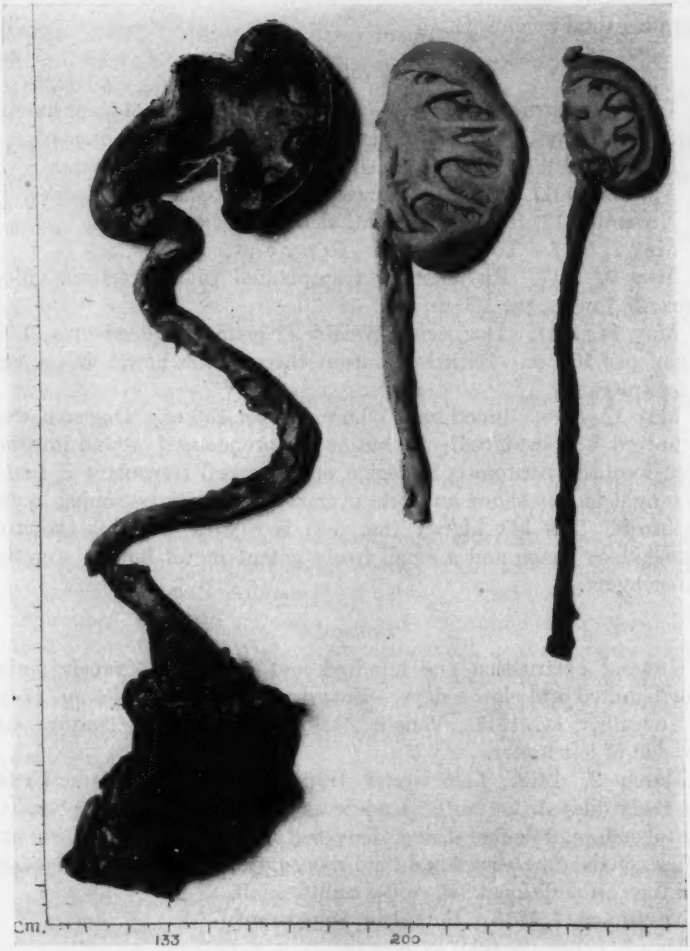


FIG. 6. Photograph (about $\frac{3}{4}$ size) of three hydronephrotic repair kidneys in dogs 17-13, 17-66 and 17-56. The first (17-13), with a capacity of 5 cc., is a seven months' repair after six months, partial obstruction, at which time the hydronephrotic sac held 895 cc. There is one repair nodule at the lower pole. The second (17-66) is a fifty-five-day repair after sixty days complete obstruction. There is a repair nodule at each pole. The third (17-56) is only a forty-five-day hydronephrosis but with three hundred and ninety days' competition with its hypertrophic mate, and shows complete atrophy.

a thirty-day complete ureteral obstruction was found capable of performing total renal work.

Protocol 4

Ureteral obstruction of forty-five days, repair period of three hundred and ninety days. No. 17-56, old grey dog, weight 21¾ pounds.

March 6, 1917. Double ligature and division of left ureter.

April 30, 1917. Left hydroureter transplanted to the bladder.

November 17, 1917. Total phthalein, 65 per cent.

May 7, 1917. Total phthalein, 50 per cent.

May 9, 1917. Right ureter transplanted to the rectum. Blood urea, 27.1 mgm. per 100 cc.

May 14, 1917. Dog sick. Weight 22 pounds. Blood urea, 156.2 mgm. per 100 cc. Phthalein output through the bowel was a very faint trace.

May 17, 1918. Blood urea, 60.6 mgm. per 100 cc. Dog somewhat improved but sacrificed. At autopsy a pronounced wound infection with localized peritonitis in region of the rectal transplant is found. The right kidney shows an acute pyelonephritis with beginning hydronephrosis. The left kidney (fig. 6-3) is a little atrophic structure with kidney shape and a small freely patent ureter but no secreting parenchyma.

Protocol 5

Ureteral obstruction one hundred and eight days, repair period four hundred and eleven days. Brown mongrel dog, male, no. 17-64.

November 14, 1917. Weight 24¼ pounds. Double ligature and division of left ureter.

March 2, 1918. Left ureter transplanted to bladder. Ureter markedly dilated (1.8 cm.). Undergoes peristalsis while lying beneath peritoneum and before being disturbed. After division of its end 200 cc. of clear amber colored fluid was emptied by its own peristalsis, and then an additional 249 cc. by compression.

November 17, 1918. Phthalein, 83 per cent.

May 7, 1919. Weight, 27 pounds.

May 14, 1919. Transplanted right ureter to rectum. Local peritonitis and death May 18, 1919. The left is a small shrunken remnant of a kidney, about which evidences of a previous pronounced collateral circulation are seen. The ureter is freely patent and there is no evidence of urinary back pressure. The kidney shows complete atrophy.

Protocol 6

Partial ureteral obstruction of six months, repair period of seven months. Large brown dog, weight 33½ pounds, no. 17-13.

August 11, 1917. Rubber band placed about lower end of left ureter so as partially to obstruct its lumen.

February 12, 1918. Weight 22½ pounds. Rubber band removed and the ureter transplanted to the bladder to insure relief of the obstruction. The ureter was very markedly dilated (1.5 cm.) and tortuous and was seen to undergo active peristalsis, during which it would shrink to about 0.8 cm. in diameter, or one-half. Upon division it emptied by its own muscular activity a little over 750 cc. of fairly clear fluid, and it was possible by compressing the hydronephrotic sac to empty 145 cc. more—total, 895 cc. The hydroureter was then transplanted to the bladder.

February 16, 1918. Dog has developed a pronounced cystitis. Urotropin given by stomach tube.

February 19, 1918. Active and well.

August 7, 1918. Weight, 35 pounds, 8 ounces. Total phthalein, 61 per cent.

September 6, 1918. Right ureter transplanted into rectum. Left kidney not palpable and left ureter about 0.6 cm. in diameter, healthy looking but tortuous and under going active peristalsis.

September 11, 1918. Death. Ureter transplant into bowel had slipped and urine pouring into peritoneal cavity, producing generalized peritonitis. The left kidney is markedly shrunken in consideration of its previous pelvic capacity of over 895 cc. and shows one single repair nodule at its lower pole (fig. 6-1), which, however, has actively functionating radicles.

Comment. The above 4 experiments illustrate the pronounced to total atrophy following hydronephrotic injury, infection and functional disuse. That hydronephrotic atrophy and destruction secondary to infection are not the sole factors in the process is shown by the results in the two following types of experiments, in which a distinct demand or need for preservation of renal parenchyma—even though it is injured—is experimentally produced at a time when the injured tissues can respond to it, and what would otherwise have atrophied from diminishing activity now hypertrophies from increased activity.

c. The repair of hydronephrosis following ureterocystoneostomy plus opposite nephrectomy. This experiment puts a most difficult test upon renal tissue. A kidney which has suffered a complete ureteral obstruction for a period is suddenly relieved by ureterocystoneostomy, and at the same time the other kidney, which has been doing all the renal work for this period, is at once removed. The remaining renal tissue, injured by the prolonged and complete obstruction, is immediately called on, not only to recover its lost function but to double it. It is remarkable that a kidney whose ureter has been completely occluded even for two weeks can show as much reserve and repair ability as to regain not only its lost function but also compensate for the loss of the opposite kidney. We have performed several times successfully such an experiment but have never been able to have an animal live after opposite nephrectomy if the obstruction was prolonged on the hydronephrotic side beyond fourteen days (protocol 7). Aside from its interest as an example of renal reserve and compensatory hypertrophy the result has its greatest significance in connection with experiment type d, in which a kidney completely obstructed for four weeks, or twice as long, recovered a complete compensation for the loss of the opposite kidney, but under distinctly different circumstances.

The first kidney at the left in figure 7 is from a cat on which there was a complete obstruction of the left ureter for twelve days and a period of repair after ureterocystoneostomy of ten days, when the right kidney was removed. The cat lived in good health for another one hundred ten days, when it was killed (protocol 7).

Protocol 7

Left ureteral obstruction of twelve days, repair period of ten days, then right nephrectomy. Sacrificed one hundred and ten days later. Large grey cat, no. 17-1.

August 3, 1917. Double ligature and division of left ureter. Loose carbolic ligature placed about right.

August 9, 1917. Total phthalein, 22 per cent.

August 15, 1917. Left ureter transplanted to bladder. Both ureters are dilated. Though the right is patent, it is more dilated than the completely obstructed left.

August 19, 1917. Total phthalein, 45 per cent.

August 25, 1917. Right nephrectomy.

September 6, 1917. Total phthalein, 35 per cent.

November 16, 1917. Cat well and active. Total phthalein, 50 per cent.

FIG. 7. Photograph of 4 cat kidneys. (1) Kidney of a cat (17-1, protocol) in which a twelve days' complete ureteral obstruction was followed by ureterocystoneostomy and opposite nephrectomy. There is complete repair. This kidney has undergone in addition a complete compensatory hypertrophy. The cat was perfectly well and had normal total function 120 days later, when sacrificed. Microphotograph of this kidney is shown in figure 20. Cat's weight, 6 pounds. (2) Kidney with a fourteen-day ureteral obstruction and a twenty-day repair of a cat weighing 8½ pounds. (3) Repair hydronephrosis of a cat weighing 3¾ pounds. Sixty days complete ureteral obstruction and one hundred days before sacrifice after ureterocystoneostomy. (4) Hypertrophic mate of 3.

December 14, 1917. Cat sacrificed on account of a severe diarrhea. The left kidney is slightly enlarged, appears normal macroscopically and shows compensatory hypertrophy microscopically (figs. 8 and 9). There is no pelvic residual or dilatation (fig. 7-1).

d. The late changes that follow in the repair of a hydronephrosis after ureterocystoneostomy when a partial obstruction is placed on the opposite ureter. In order to show that the atrophy and disap-

pearance in the course of one to two years (type b, experiment) of what was at an earlier period of one to three months of repair a well preserved and respectably repaired hypertrophic nodule, (type a, experiment) in a hydronephrosis relieved of its obstruction, are due more to loss of function and disuse atrophy in consequence of an unequal competition with the increased function and compensatory hypertrophy of the opposite healthy kidney,

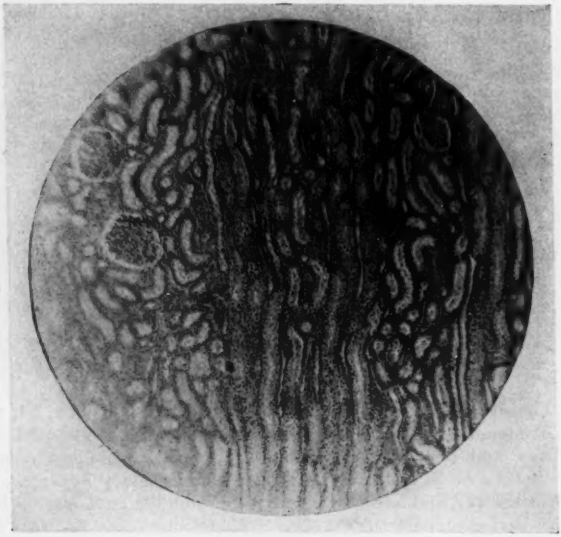


FIG. 8. (Cat 17-1, protocol 7.) Microphotograph (low power) of the twelve-day hydronephrotic repair as well as complete compensatory hypertrophic kidney shown in figure 7-1. The tubules seem to be lengthened and more tortuous, as well as broader. Glomeruli are also hypertrophied.

than to progressive destruction from degeneration and disease, one can equalize competition by a gradual injury of the compensatory side. The degenerative changes instituted by the primary hydronephrosis remain unaltered, so that if they are responsible for the final atrophy in one experiment they ought to produce atrophy just the same in the other. Variations in the local resistance to the action of infection with functional activity and

inactivity are also probabilities worthy of mention in considering renal atrophy from disuse, and constitute a problem for experimental study.

A gradual injury of the complete compensatory kidney can be produced simply by a partial obstruction of its ureter with a rubber band. In a year's time there will be practically a com-

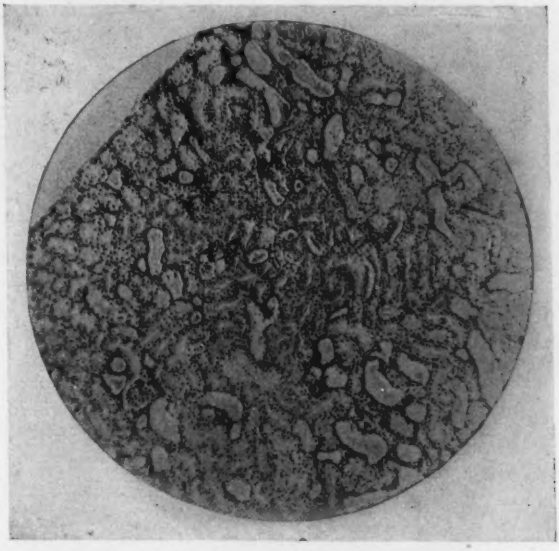


FIG. 9. (Cat 17-1, protocol 7.) Microphotograph (low power) of another area of the repair kidney shown in figure 7-1. The injury produced by the twelve-day ureteral obstruction is manifest by the persistence of dilated and destroyed tubules intermixed with hypertrophied and healthy tubules. Two atrophic glomeruli are seen in the section.

plete hydronephrotic atrophy of its previous hypertrophic tissues (protocol 6). To all intents and purposes it is a dead kidney. The animal will now have no secreting renal tissue, provided the degeneration proceeded on the hydronephrotic repair side, (as it did in type b, experiment), and death from renal insufficiency would result. But the gradual increase infunctional demand so

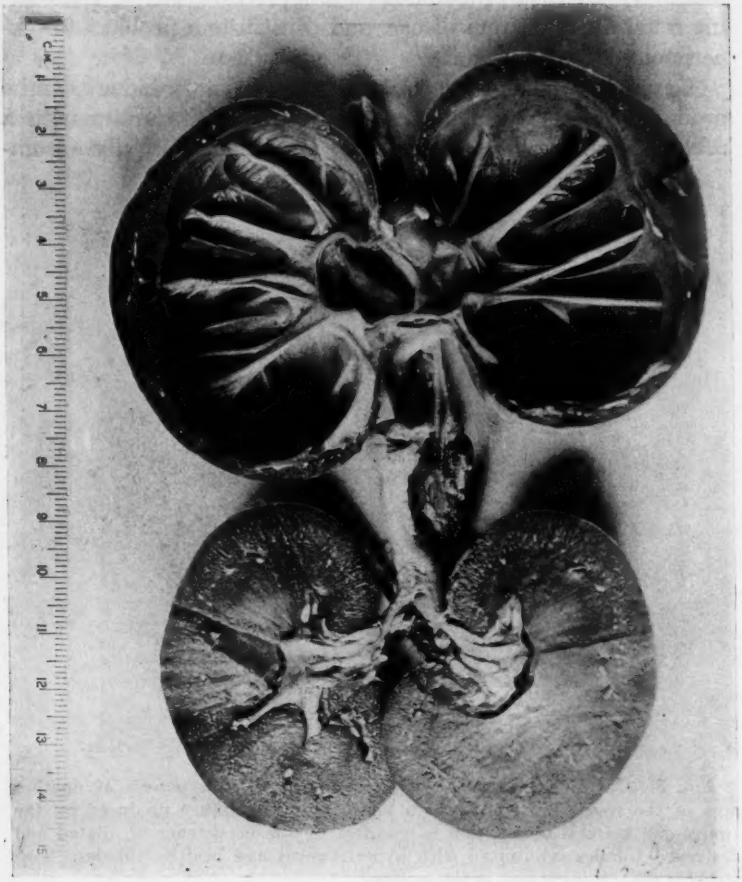


FIG. 10. (Dog 22-39.) Photograph of a simple hydronephrosis of thirty days complete ureteral obstruction and the opposite hypertrophic kidney. Hydronephrotic atrophy is quite pronounced. The arterial systems of kidneys of forty-one days' hydronephrosis injected with $BaSO_4$ are shown in the next figure (figures 11 and 12).

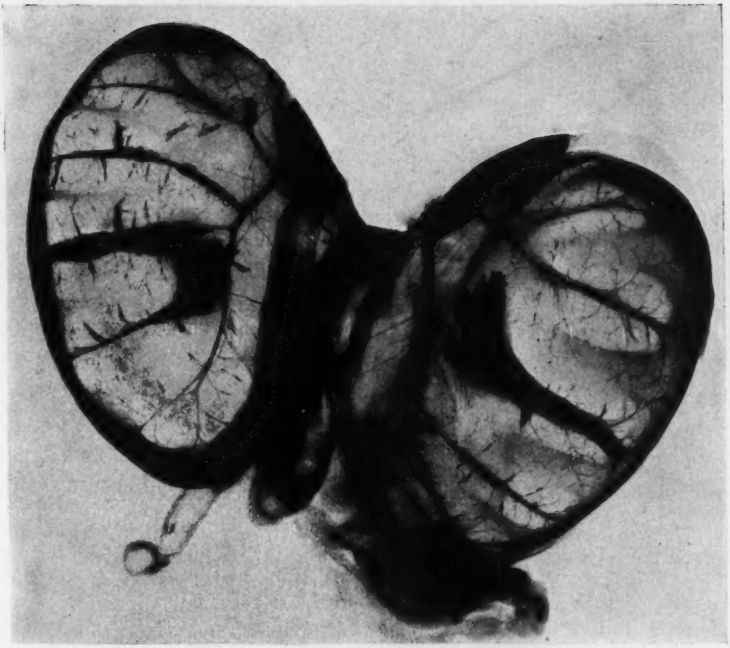


FIG. 11. (Dog 22-12.) Photograph of roentgenogram of barium sulphate arterial injection of a forty-one-day hydronephrosis in which the dog was sacrificed and barium sulphate solution injected at once after death. The attenuation of the circulatory tree of the hydronephrotic kidney is remarkable and is particularly significant when compared to the reproduced arterial tree of the kidney as shown in figure 12, which, although a forty-two-day hydronephrosis, had had two days' relief from back pressure, due to ureteral obstruction.

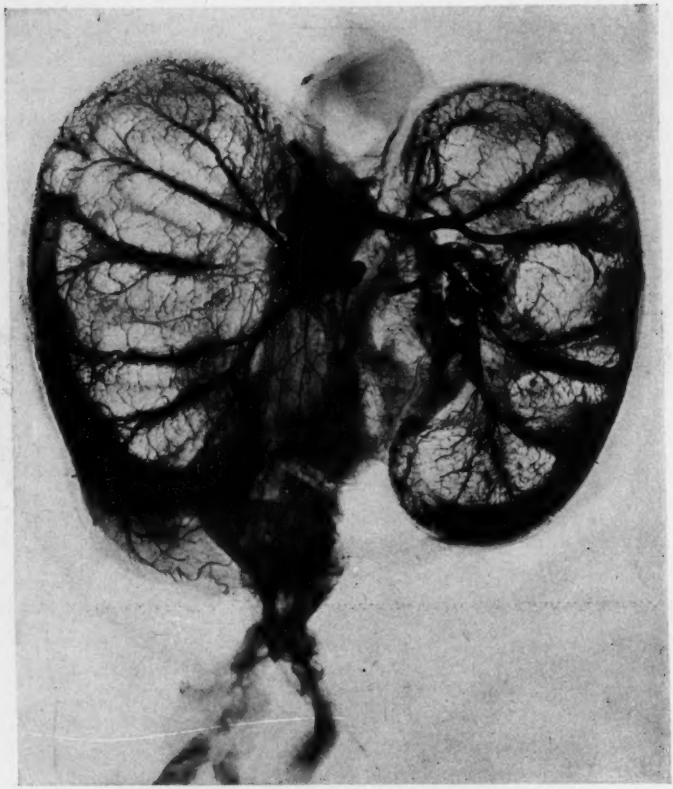


FIG. 12. (Dog 22-36.) Photograph of roentgenogram of barium sulphate arterial injection of a forty-two-day hydronephrosis but in which the dog was sacrificed two days after the ureteral obstruction had been relieved. The same solution of $BaSO_4$ was used under equal pressures for both preparations shown in figures. Yet there is a remarkable revascularization apparent in the kidney relieved of the arterial back pressure, and this remarkable increase in blood supply must have been almost immediately after the removal of the intrapelvic pressure. It is significant of repair possibilities and of great interest in connection with the result in dog 21-39, figures 13 and 14.

progressively stimulates an otherwise hopelessly injured kidney or so sufficiently raises its resistance to the injurious action of infections, toxins, etc., that it regains not only its lost ability but so hypertrophies that it now easily and successfully carries the burden of total renal work (protocol 8). Figure 10 is a photograph of a simple thirty-day hydronephrosis in a dog and is presented for comparison. It is seen that there is already quite a considerable degree of hydronephrotic atrophy. In figure 16 is shown a kidney which had had two days longer complete obstruction, and yet it now shows no evidence, either in gross or microscopically, of hydronephrotic atrophy. The demand for activity has been transferred from the right compensatory side to the repair side, which has responded to this need in a truly wonderful manner. It is a remarkable experimental example of a final anatomical readjustment in renal counterbalance.

Changes in the circulation that follow relief of ureteral obstruction are beautifully shown in figures 11 and 12 (protocols 10 and 11) and are significant of the dependence of renal function on blood supply. This amount of revascularization allows one to understand the remarkable anatomical readjustment in type d, experiment, the following protocol of which is given in detail:

Protocol 8

Dog 21-39. Shepherd, male, weight 42 pounds.

November 1, 1920. Ligation of left ureter. Blood: Urea nitrogen, 18 mgm. per 100 cc.; non-protein nitrogen, 34 mgm. per 100 cc. Phenolsulphonephthalein, 70 per cent in two hours. The abdomen is opened in a midline incision under the usual ether anaesthesia and aseptic precautions. The incision extends from the symphysis pubis upward about 4 cm. The bladder is seized with the fingers and drawn gently upward into the wound. A double silk sature is passed beneath the left ureter just above its junction with the bladder and with it the ureter is firmly and doubly ligated. The ureter is severed between these two ligatures and the stumps are dropped back into the wound. The abdominal wound is closed with no. 2 chromic sutures. During the next week the dog is seen to make an uneventful recovery.

December 2, 1920. *Left ureterocystoneostomy.* Under ether anesthesia and aseptic precautions the abdomen is opened in the midline.

The bladder is lifted up into the wound and the large tortuous left hydroureter is seen. It is approximately 1 cm. in diameter and filled tightly with urine. The end of the ureter is carefully freed from its bed and about 100 cc. of slightly smoky urine is drained into a large test tube when the ligated tip is cut off. A no. 00 catgut suture is then passed through the adventitia of the ureter, which is slit open for about 0.5 cm. on the side opposite to the suture, the free ends of which are threaded into small milliner's needles. A short incision is then made through the bladder wall in its posterior aspect just a little lateral to the midline and the threaded milliner's needles passed through this and out through the bladder wall about 1 cm. above their point of entry, where they appear with a 3 mm. space between them. Traction on the catgut draws the ureter through the bladder wall and when the ends of the fine catgut are tied the ureter is held with its slit-end open within the bladder. The ureter is more firmly fixed to the bladder wall externally with fine interrupted stay sutures, which pierce the adventitia of the ureter and the external coats of the bladder. The abdominal wound is closed with no. 2 chromic sutures. Recovery is prompt and without incident.

December 9, 1920. *Partial ligation of right ureter.* Under ether anesthesia and surgical asepsis the abdomen is opened in the midline just below the umbilicus. The peritoneum is smooth and glistening. There are few adhesions in the region of the bladder vault. The right ureter is identified in its bed as low down as possible without disturbing the recent operative area behind the bladder. A short length of ureter is freed in an area about 3 cm. from its point of entry into the bladder and a rubber band 2 mm. wide is placed around it and stretched. The ends of the band thus stretched are tied with silk so as to form a moderate constriction of the ureter. The wound is closed with no. 2 chromic. The animal recovered slowly from the operation, eating little for four or five days. The wound healed readily, however. A period in which his condition seemed improved then followed, lasting four to five days. The dog again refused food for a second period of five or six days and lay very still in his cage. Following this he slowly grew better. A month after operation he seemed quite normal and ate normal amounts.

November 29, 1921. Blood from jugular for nitrogen partition: Urea nitrogen, 26 mgm. per 100 cc.; non-protein nitrogen, 49.0 mgm. per 100 cc.; creatinine, 1.93 mgm. per 100 cc.

January 4, 1922. *Sacrifice. Autopsy.* The dog is in excellent condition; weight 42.5 pounds. Coat is long and glossy. Has been passing well formed stools and clear urine. Phenolsulphonephthalein

first hour, 53 per cent; second hour, 20 per cent. Blood: Urea nitrogen, 21 mgm. per 100 cc.; non-protein nitrogen, 41 mgm. per 100 cc. Killed with ether. There are three operative scars on the abdominal wall, one on each side and parallel to the penis and one in the midline above the penis. The wound areas are all tightly closed and uninfected. There are some scant adhesions to the under surface of each of the abdominal wounds. The mesentery only is adherent here. The abdominal organs, except for the genito-urinary tract, present no lesions whatever. Heart is not enlarged, shows no pathological alterations. Lungs clear. A sample of urine from the right ureter is clear and shows a considerable amount of pigment. The urine from the left ureter is cloudy. It shows an equal amount of pigment. The urinary tract is shown in the reproduced photograph (fig. 13).

Kidneys. The left kidney is normal in shape and slightly enlarged. It collapses readily at the hilus with pressure, showing a moderate degree of hydronephrosis. The ureter of this kidney is very large, being 1 cm. in diameter. It is not tortuous. Its opening lies in the midline of the bladder posteriorly and is fully patent. It readily admits a no. 8 F. catheter. This kidney shows a heavy venous network over its surface external to the capsule. Microscopic section shown in figure 14. The right kidney is very large, has a very thin wall. There is a crescentic nodule at its lower pole 1.5 cm. thick and 7 cm. long, a microphotograph of which is reproduced in figure 15. In all other areas the wall is of paper thinness. The ureter is slightly larger than that of the opposite side. It is 1.3 cm. in diameter. It is much thinner than the left ureter and very tortuous. Near the bladder it presents an obstructed area, at which point the rubber band placed December 9, 1920, is localized. Beyond this it is of normal diameter. The right uretero-vesical orifice through which this ureter opens is normal in all respects and readily admits a no. 4 F. catheter. Gentle pressure on the hydronephrotic sac causes a flow of fluid through this ureteral orifice. The wall of the bladder is normal in appearance. The urethra presents no constrictions nor abnormalities. The respective sizes and weights of the two kidneys were as follows:

	LENGTH (POLE TO POLE)	WIDTH (SIDE TO SIDE)	DEPTH (HILUS TO GREATER CURVATURE)	WEIGHT	PELVIC CAPACITY
	cm.	*cm.*	*cm.*	*grams*	*cc.*
Left kidney....	6.95	2.5	3.0	47	5
Right kidney...	16.0	8.0	7.5	52	400

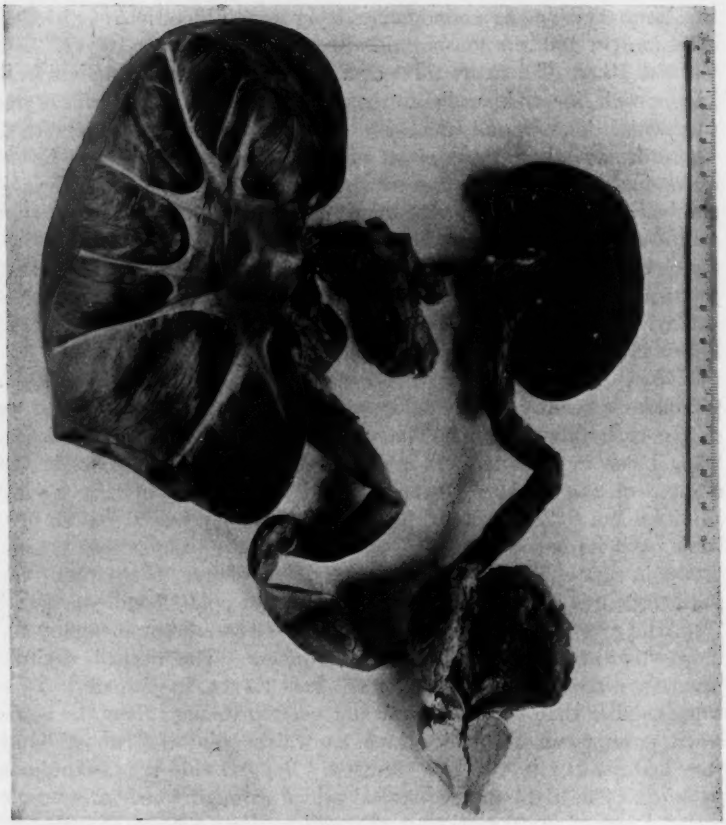


FIG. 13. (Dog 21-39, protocol 8.) Photograph of a thirty-one-day hydronephrotic repair days after ureterocystoneostomy and partial obstruction of the opposite ureter. The freely patent opening of the hydroureter into the bladder is marked by an end of a white match stick. This ureter has not shrunken and is almost as large as the opposite hydroureter belonging to an almost complete hydronephrotic atrophy. This kidney therefore must have been after its thirty-one-day complete obstruction markedly hydronephrotic and in every way analogous in size and condition to the simple thirty-day hydronephrosis shown in figure 10. The difference between them is quite evident after section. The thirty-one-day hydronephrosis has shrunken considerably but preserved its kidney shape and undergone a remarkable repair. There has been a complete anatomical counterbalance, now the previously dead kidney is doing normal and double function and the previously compensatory side has undergone complete hydronephrotic atrophy.

FIG. 14. (Dog 21-39, protocol 8.) Microphotograph of the left hydronephrotic repair kidney of figure 13. Hypertrophy of tubules and glomeruli is evident. Dilatation of tubules is seen to persist in areas, but there is little evidence of a previous thirty-one-day hydronephrosis.

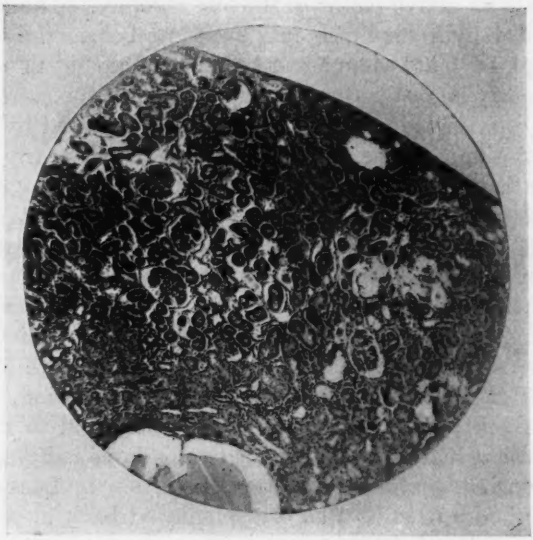


FIG. 15. (Dog 21-39, protocol 8.) Microphotograph of an area in the remnant of parenchyma left at the upper pole of the large hydronephrotic right kidney of three hundred and ninety days partial ureteral obstruction. Glomeruli persist the longest; tubules have almost disappeared.

The nitrogen content of the urine from the left kidney is: Urea nitrogen, 0.0045 gram in 1 cc.; non-protein nitrogen, 0.0065 gram in 1 cc.

The nitrogen content of the urine from the right kidney is: Urea nitrogen, 0.0039 gram in 1 cc.; non-protein nitrogen, 0.0068 gram in 1 cc.

e. Control experiments with simple ureteral transplantation without previous hydronephrosis. There may be readers who feel that the late atrophy of experiment type b is nothing more than the result of the disturbance following ureteral transplantation and that transplantation of a ureter any place produces enough injury to lead to late atrophy provided the other kidney is healthy. The experiment just cited would seem sufficient proof to the contrary. An imperfect ureteral transplant leads by back pressure to renal injury, and the final atrophy in the above counterbalance experiments is no doubt hastened according to the degree of this injury; but the fact that by placing a need for this tissue delays or prevents atrophy (type c), whereas the lack of such need hastens it, indicates that in the latter case lowered function or disuse is an active factor in the late atrophy. The atrophy of a thirty-day hydronephrosis in view of its being opposed to an hypertrophied mate completely capable of doing all the work will obviously be faster than a kidney equal at the start with its unhypertrophied fellow when conditions are altered by ureteral transplantation. If the transplantation is at all nearly successful such a kidney will never atrophy. There are many instances in the literature of vesical transplantation in which the kidney on the transplanted side has remained healthy for years. The only cause for late atrophy when both kidneys are equal at the time of the transplant is injury from ureteral obstruction or from infection, either of which creates an unequal competition from a qualitative standpoint. Coffey has had dogs survive for many months after unilateral uretero-rectal transplantation, and the kidney on this side found to be normal and equal to its mate, and Carrel has had dogs survive for two and one-half years after kidney excision, perfusion and then inversion in Locke's solution for 2 hours when it was transplantated back in place and the ureter sutured together and opposite nephrectomy two

weeks later and finds the animal in good health and the kidney normal in appearance after this long period. Perhaps his result would have been quite different if the good kidney had remained undisturbed. This question of the injury to a kidney in consequence of ureteral transplantation is of significance in the interpretation of the results of the following experiments.

2. Ureteroduodenostomy. When a ureter has been successfully transplanted into the duodenum the kidney will continue to function but its work is as completely nullified, so far as urinary excretion is concerned, as by nephrectomy, since there is complete urinary reabsorption.[4] An analogous result would follow the transplantation of a ureter into a vein, an experiment actually performed by Reid. What happens to the transplanted kidney? Will it hypertrophy or will it atrophy?

Protocol 9

Dog 22-39. Thirty-day hydronephrosis; sacrifice. For comparison with protocol 8, Dog 21-39. Little black male mongrel, weight, 19 pounds. Condition excellent.

February 16, 1922. Blood urea nitrogen, 18 mgm. per 100 cc.; non-protein nitrogen, 30 mgm. per 100 cc.

February 17, 1922. Left ureter ligated near the bladder.

March 18, 1922. Blood urea nitrogen, 18 mgm. per 100 cc.; non-protein nitrogen, 34 mgm. per 100 cc. Sacrificed; ether narcosis.

Autopsy. The animal is in excellent condition. There is a midline sear over the lower abdomen. Heart and lungs normal. Abdomen free from adhesions. All organs appear normal. Genito-urinary tract: moderately enlarged kidney on right, normal in appearance. The left kidney is very large and consists of a fluid-filled sac having a capacity of 130 cc. and with only a small amount of parenchyma remaining. The ureter is large and follows a slightly tortuous course to the bladder. It is firmly ligated just above the point of entry into the bladder. The fluid cannot be forced beyond this point from above downward. The bladder and urethra are normal (fig. 10).

[4] This subject has been more fully dealt with in collaboration with Dr. A. E. Belt in a paper upon ureteral transplantation presented before the Urological Section of the A. M. A., May 22, 1922, at St. Louis.

Kidney measurements

	WEIGHT	LENGTH	WIDTH	DEPTH
	grams	*cm.*	*cm.*	*cm.*
Left kidney.....	37 (empty)	6.52	3.85	4.32
Right kidney....	45	5.75	3.86	3.42

Protocol 10

Protocol of forty-one-day hydronephrosis for comparison with dog 22-36. Dog 22-12, White Spitz, young adult, weight, 23 pounds.

November 30, 1921. Under ether anesthesia, left ureter firmly ligated just above bladder.

January 9, 1922. Sacrificed; ether narcosis.

Autopsy. No abnormalities are noted in the thoracic cavity. The abdominal contents are negative except for the presence of a huge hydronephrotic sac in the left kidney region. A large ureter is also present. The right kidney is a little larger but normal in appearance. Bladder and urethra normal. $BaSO_4$ injection shown in figure 11.

Kidney measurements

	WEIGHT	LENGTH	WIDTH	DEPTH	PELVIC CAPACITY
	grams	*cm.*	*cm.*	*cm.*	*cc.*
Left kidney....	40 (empty)	8.6	5.8	5.15	160
Right kidney...	31	5.7	2.25	3.3	2

Protocol 11

Dog 22-36. Young adult, male, Airedale. Distemper eight months previously, followed by an intermittent twitch of the voluntary muscles, which still remains. Weight, 25 pounds. The dog is somewhat underweight. General condition: good.

February 14, 1922. Left ureter ligated at uretero-vesical junction. Midline incision; ether anesthesia.

March 29, 1922. Under ether anesthesia the left ureter is opened through a midline incision and 185 cc. of a smoky urine is removed from the sac through a no. 8 F. soft rubber catheter, which was run through the dilated ureter to the kidney pelvis. The catheter is carefully manipulated and gentle suction applied until no further contents can be removed. The ureter is again ligated and the wound closed. An analysis of this material shows that it contains a great

number of blood cells. There are very few pus cells. The fluid from a centrifuged specimen shows the following contents: Urea nitrogen, 0.0019 gram in 1 cc.; non-protein nitrogen, 0.0056 gram in 1 cc.; chlorides, 0.0068 gram in 1 cc.

March 31, 1922. Blood urea nitrogen, 19 mgm. per 100 cc.; non-protein nitrogen, 36 mgm. per 100 cc. There is no reaction about the wound. Condition excellent. Under ether anesthesia the ureter is again opened and a no. 8 F. soft rubber catheter is introduced to the kidney pelvis; 18 cc. of slightly blood-tinged fluid is removed from the sac. This material contains many red blood cells; no pus. The fluid from a centrifugalized specimen shows: Urea nitrogen, 0.0005 gram in 1 cc.; non-protein nitrogen, unreadable; chlorides, 0.0077 gram in 1 cc.

Ether anesthesia was carried to narcosis and an autopsy performed. The bladder urine shows the following contents: Urea nitrogen, 0.0081 gram in 1 cc.; non-protein nitrogen, 0.0191 gram in 1 cc.

Autopsy. Heart and lungs normal. Abdominal contents show neither abnormalities nor pathological conditions. The right kidney is a little large; capsule seems tight. There is no reaction about it; no adhesions. The left kidney reveals a number of large vessels coursing over its surface. It is approximately the same size as the normal kidney on the opposite side. Its ureter is considerably dilated, though not tortuous. $BaSO_4$ injection of left kidney shown in figure 12.

Kidney measurements

	WEIGHT	LENGTH	WIDTH	DEPTH	PELVIC CAPACITY
	grams	*cm.*	*cm.*	*cm.*	*cc.*
Left kidney....	35 (empty)	7.05	3.05	3.1	20
Right kidney...	58	6.65	3.1	3.3	2

Protocol 12

Right ureteroduodenostomy; left nephrectomy. Death. Dog 138, adult, female, Airedale, weight 29 pounds. Condition excellent.

July 21, 1919. Blood urea nitrogen, 14 mgm. per 100 cc. Phenolsulphonephthalein, 79 per cent in two hours.

July 23, 1919. Right ureteroduodenostomy by H. P. Smith and A. E. Belt. Ether anesthesia, Fowler-Coffey method.

August 8, 1919. Recovery has been uneventful. Blood urea nitrogen, 40 mgm. per 100 cc. Phenolsulphonephthalein, 30 per cent in two hours.

September 18, 1919. Blood urea nitrogen, 60 mgm. per 100 cc. Phenolsulphonephthalein, 70 per cent in two hours. A left nephrectomy is done, lumbar route. Kidney measures: Length 5.5; width, 3.2; and depth, 3.2 cm.

September 20, 1919. Blood urea nitrogen, 72 mgm. per 100 cc.

September 22, 1919. Blood urea nitrogen, 190 mgm. per 100 cc.

September 26, 1919. Blood urea nitrogen, 252 mgm. per 100 cc.;

September 28, 1919. Blood urea nitrogen, 340 mgm. per 100 cc. watery stools. Constantly drinks water; hair sticky, with penetrating odor.

September 29, 1919. 8:00 a.m.: Blood urea nitrogen, 485 mgm. per 100 cc. Catatonic. 5:15 p.m.: Pulse 148 per minute; very weak, eyes glassy, hair sticky, penetrating odor. At 8:10 p.m. a slight rose tinge is noted in the liquid yellow stools which are constantly passing; rigor, with a slight, fine tremor. Pulse rapid, growing irregular. Cheyne-Stokes respiration begins. The eye reflexes disappear. Death at 8:20 p.m.

Autopsy. Rigor mortis marked. Heart and lungs normal. Abdominal contents show normal sheen; intestines in active peristalsis; no adhesions. Right ureter runs without interruption into the duodenum; no kinks; no dilatations. It is about 4 mm. in diameter. The implanted ureter forms a slight dimple on the mucous surface of the gut. Very light pressure on the renal pelvis causes a clear amber fluid to flow through the papilla into the gut lumen. No leakage; no adhesions about the implanted area. Right kidney slightly large but normal in appearance. Pelvic capacity, 7 cc.; slight dilatation.

Kidney measurements

	LENGTH	WIDTH	DEPTH	
	cm.	*cm.*	*cm.*	
Right kidney...	7.0	3.8	3.7	Removed at autopsy, September 29, 1919
Left kidney....	5.5	3.2	3.2	Removed at operation, September 18, 1919

Protocol 13

Right ureteroduodenostomy with left nephrectomy. Sacrifice. Dog 18-14, adult, male, weight 49 pounds. Condition excellent.

October 6, 1918. Blood: Urea nitrogen, 14 mgm. per 100 cc. Phenolsulphonephthalein, 82 per cent in two hours.

October 7, 1918. Right ureteroduodenostomy, ether anesthesia. Fowler-Coffey method.

November 5, 1918. Condition excellent. Wound healed. Blood: Urea nitrogen, 14 mgm. per 100 cc. Bread and milk diet.

November 21, 1918. Left nephrectomy, lumbar route, ether anesthesia.

November 22 to December 3, 1918. Blood: Urea nitrogen steadily rose to 220 mgm. per 100 cc. Dog is dull, somewhat apathetic. Sacrificed.

Autopsy. Slight degree of hydronephrosis and hydroureter. Ostium into duodenum functions, however, and a stream of urine enters duodenum when gentle pressure is applied to pelvis. No leakage, no adhesions. Other tissues appear quite normal.

Protocol 14

Right ureteroduodenostomy; left nephrectomy. Right ureter removed from duodenum and transplanted to skin. Dog 19-25. Large, brown water spaniel, adult, male. Weight 36 pounds.

September 6, 1919. Blood urea nitrogen, 10 mgm. per 100 cc. Phenolsulphonephthalein, 75 per cent in two hours.

September 7, 1919. Right ureteroduodenostomy, Fowler-Coffey method.

September 10, 1919. Blood urea nitrogen, 16 mgm. per 100 cc.

September 14, 1919. Blood urea nitrogen, 19 mgm. per 100 cc.

September 24, 1919. Blood urea nitrogen, 15 mgm. per 100 cc. Phenolsulphonephthalein, 30 per cent in two hours. Left nephrectomy, lumbar route.

September 25, 1919. Blood urea nitrogen, 32 mgm. per 100 cc. From this figure the blood urea nitrogen steadily rose during the next six days.

October 1, 1919. 8:00 a.m.: Blood urea nitrogen, 227 mgm. per 100 cc. Ureter of right kidney brought from duodenum to the skin of the right lumbar region. A short cannula is left in its lumen. Previous to the operation the animal had been dull and apathetic. Shortly after recovery from the ether anesthetic he became very much brighter. 10:00 a.m.: Blood urea nitrogen, 190 mgm. per 100 cc. 4:15 p.m.: Blood urea nitrogen, 122 mgm. per 100 cc. Phenolsulphonephthalein, 21 per cent.

October 2, 1919. Blood urea nitrogen, 48 mgm. per 100 cc.

October 3, 1919. Blood urea nitrogen, 31 mgm. per 100 cc.

October 4, 1919. Blood urea nitrogen, 14 mgm. per 100 cc.

October 5, 1919. Blood urea nitrogen, 17 mgm. per 100 cc.

October 6, 1919. Blood urea nitrogen, 18 mgm. per 100 cc. Weight, 21 pounds. Phenolsulphonephthalein, 19 per cent in two hours. Ureteral opening still draining freely. Killed with ether.

Autopsy. Emaciated, wet. Right ureter draining to right loin. Some pus and granulations on skin surface at this area. Abdomen, smooth, glistening, sheen. Course of ureter to skin is tortuous but no dilatation is noted. Ureter neither distended nor constricted. Pelvic capacity, 10 cc. No adhesions. Heart and lungs normal. Duodenal contents normal; formed stools in rectum.

Protocol 15

Double renal hypertrophy. Right ureteroduodenostomy, nephrectomy, transplantation of right ureter to skin. Dog 20-90, adult, female, doschhund, black, weight, 20 pounds. Condition excellent.

March 3, 1920. Blood: Urea nitrogen, 13.5 mgm. per 100 cc. Phenolsulphonephthalein, 85 per cent in two hours.

March 24, 1920. Right ureter transplanted to duodenum, Fowler-Coffey method. Phenolsulphonephthalein immediately after recovery from operation. First hour, 40 per cent; second hour, 10 per cent; total, 50 per cent.

August 17, 1920. Blood: Urea nitrogen, 17 mgm. per 100 cc.

September 7, 1920. Phenolsulphonephthalein: First hour, 40 per cent; second hour, 5 per cent, total, 45 per cent. Left kidney removed, lumbar route.

September 15, 1920. Blood: Urea nitrogen, 359 mgm. per 100 cc.; creatinine, 2.13 mgm. per 100 cc. Right ureter brought from duodenum to skin. Phenolsulphonephthalein 15 per cent in two hours. Appearance time, twenty-five minutes.

September 16, 1920. Blood: Urea nitrogen, 191 mgm. per 100 cc. Pulse weak, thready. Died early in morning.

Autopsy. Mucous membrane of gums and under surface of the tongue shows multiple ulcerations covered with a greenish, sloughing exudate. The gums are raw and blood-stained. There is a granulating sinus at the site of the nephrectomy done September 7. The sinus does not extend to the peritoneum. Abdominal peritoneum shows no loss of sheen. The ureteral stump into the gut is firmly closed, with no adhesions about it. The projecting papilla on the mucous side of the gut will admit small probe. Left kidney slightly large, pelvis

dilated slightly, ureter slightly thickened to two times normal diameter. Lungs show three bluish, gelatinous areas, about 2 to 3 cm. in diameter. Liver and spleen show marked passive congestion.

Kidney measurements

	LENGTH	WIDTH	DEPTH	
	cm.	*cm.*	*cm.*	
Right kidney...	5.35	3.14	3.12	Removed at autopsy, September 16, 1920
Left kidney....	4.55	2.4	2.8	Removed by nephrectomy, September 7, 1920

Protocol 16

Functional study of right and left kidney, with ureteroduodenostomy. Dog 22-16. Brown and white female mongrel, weight 21 pounds.

November 29, 1921. Blood: Urea nitrogen, 24 mgm. per 100 cc.; non-protein nitrogen, 47 mgm. per 100 cc.

January 2, 1922. Blood: Urea nitrogen, 22 mgm. per 100 cc.; non-protein nitrogen, 38 mgm. per 100 cc.

January 14, 1922. Right ureteroduodenostomy, Fowler-Coffey method. The right kidney measures: Length, 4.90 cm., width, 2.45 cm., depth, 2.55 cm.

March 7, 1922. Blood: Urea nitrogen, 16 mgm. per 100 cc.; non-protein nitrogen, 34 mgm. per 100 cc. Phenolsulphonephthalein intravenously: First fifteen minutes, 14 per cent; second fifteen minutes, 12 per cent. The dog is in excellent condition. Given 500 cc. water by mouth; 100 cc. Locke's solution intravenously. Anesthetized with ether, the abdomen is opened in the midline and a catheter is placed in each ureter. The anesthetic is continued while the secreted urine is collected. The resulting urine shows the following concentration and amounts:

	TEN-MINUTE PERIOD FOLLOWING OPERATION			TWENTY-MINUTE PERIOD		
	Amount	Total nitrogen	Color	Amount	Urea nitrogen	Non-protein nitrogen
	cc.	*grams in 1 cc.*		*cc.*	*grams in 1 cc.*	*grams in 1 cc.*
L. K. Urine.....	5	0.0142	Amber	10	0.0056	0.0153
R. K. Urine (ureteroduodenostomy.....	12	0.0061	Light amber	40	0.0042	0.0125

Phenolsulphonephthalein. 2 cc., or 12 mgm., of phenolsulphonephthalein were injected intravenously five minutes after the cannulae were placed in each ureter. The appearance time on the left was four minutes, and on the right, six minutes. Only a faint color of phenolsulphonephthalein was visible in each twenty-minute sample of urine. The concentration was therefore read directly, without diluting, in a Helige colorimeter against a standard made from 2 cc., or 12 mgm., of phenolsulphonephthalein in 1000 cc. of slightly alkaline water. The reading on each side was found to be 5 per cent under these conditions. Since four times as much urine was put out on the transplanted, or right side, it may be stated that four times the amount of phenolsulphonephthalein was excreted by this side. The actual figures, when calculated, are: Left kidney, 0.05 per cent, or 0.006 mgm. in twenty minutes; right kidney, 0.20 per cent, or 0.024 mgm. in twenty minutes. The ether anesthesia was carried to narcosis and an autopsy performed.

Autopsy. (March 7.) Heart and lungs normal. Abdomen: the peritoneum is of normal sheen; no abnormalities noted. The left kidney is a little large but normal in shape. The right kidney is quite large and shows a definite amount of hydronephrosis. Its ureter runs around its lower pole through a mass of loosely formed adhesions and ends in the duodenum. The ureter is dilated definitely. The kidney has a large pelvis, which holds about 12 cc. The parenchyma is encroached upon by the large calyces to a considerable extent. Fluid can readily be forced through the ureter into the duodenum. The other organs are normal.

Kidney measurements

	WEIGHT	LENGTH	WIDTH	DEPTH	PELVIC CAPACITY
	grams	*cm.*	*cm.*	*cm.*	*cc.*
Left kidney....	35 (empty)	6.85	3.3	3.3	20
Right kidney...	32	5.5	2.7	3.1	3

a. The early changes in the two kidneys following transplantation of one ureter into the duodenum. It is possible successfully to transplant a ureter into the duodenum in a high percentage of cases. There is little danger of an ascending infection, which so commonly follows transplantation into the lower gut, and if

the technic of Fowler-Coffey is modified so that the ureter is loosely placed, the danger of secondary hydronephrosis may be escaped. A successful transplant therefore will cause little if any injury of the corresponding kidney. That this is true is proved by the direct examination of the kidney within a period of two to four months of the transplant, when there is found no anatomic evidence of inflammation or injury from back pressure upon histologic study of these kidneys. The functional capacity of these kidneys is also established by a number of experiments in which the good left kidney has been removed two to three months after the right uretero-duodenal transplant. In the one group in which nothing further is done the animal invariably dies in nine to ten days, with the same symptoms and signs that follow double nephrectomy (protocols 12 and 13). But in the other group on the eighth or ninth day, when the dog is comatose and shows a blood nitrogen retention of 485 or more milligrams per 100 cc., the right ureter may be transplanted to the skin. The transplanted kidney, instead of frantically pouring large quantities of urine into the duodenum for reabsorption, will now perform actual excretion and will fully recover and renal function be fully restored (protocols 14 and 15). The healthy condition of the right kidney can also be shown after two to three months duodenal transplantation by comparing its function under ether or urethane with the healthy left side, with ureteral catheter in place, as shown in protocol 16.

The left kidney in all of these experiments is burdened with double the work as effectively as if right nephrectomy had been performed. In consequence it undergoes compensatory hypertrophy just as quickly and completely. But the right kidney, as shown in the above paragraph, remains healthy, uninfected and in the cases of successful transplantation, uninjured by back pressure. Its blood supply has not been disturbed. The blood carried through it is of the same character as through the left kidney. Why should it not also hypertrophy? Examination of the two kidneys by sacrifice of the animal at about the second or third-month period does show a bilateral compensatory hypertrophy. The transplanted kidney, which works uselessly

so far as urinary excretion goes, responds nevertheless to the same double stimulus in an apparently equally efficient manner as the undisturbed kidney upon which total renal function solely depends. This is well illustrated in figures 16 and 17 and in protocols 15 and 17.

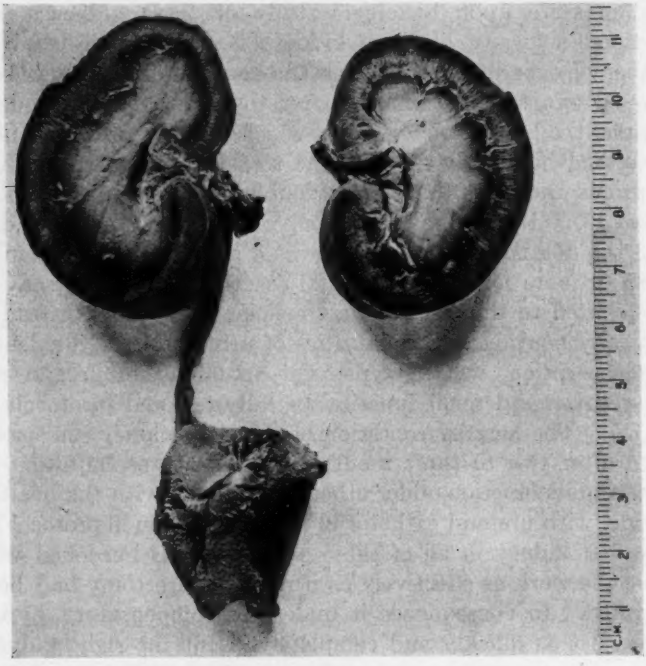


FIG. 16. (Dog 19-139, protocol 13.) Photograph of the two kidneys of bilateral hypertrophy after sagittal section. The hypertrophic condition of the transplanted kidney is apparent and there is no evidence of urinary obstruction, no pelvic nor ureteral dilatation.

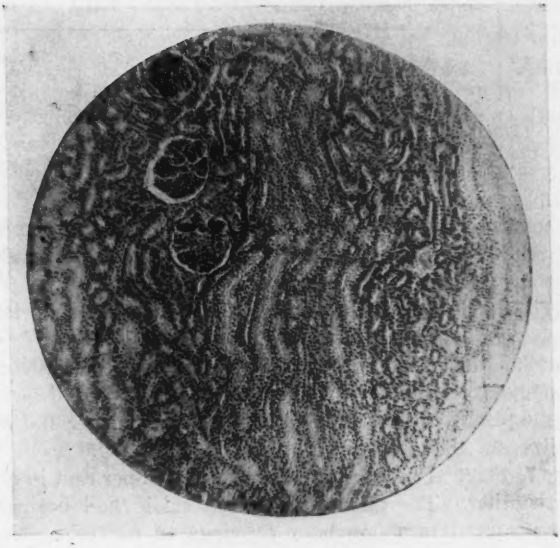


FIG. 17. (Dog 19-139, protocol 13.) Microphotograph of the right kidney of figure 16, whose ureter was transplanted into the duodenum eighty-three days ago. The hypertrophy and healthy preservation of this kidney is clearly demonstrated.

Protocol 17

Double renal hypertrophy. Right ureteroduodenostomy. Killed in eighty-three days. Dog 139, adult, female, black spaniel, weight 19.1 pounds.

July 21, 1919. Blood: Urea nitrogen, 15 mgm. per 100 cc. Phenolsulphonephthalein, 76 per cent in two hours.

July 22 to August 28, 1919. Blood: Urea nitrogen ranged from 15 mgm. per 100 cc. to 13.5 mgm. per 100 cc.—5 determinations.

August 28, 1919. Right ureteroduodenostomy, ether anesthesia.

September 8, 1919. Blood: Urea nitrogen, 19 mgm. per 100 cc.; phenolsulphonephthalein, 75 per cent in two hours.

November 18, 1919. Killed accidentally—stomach tube in lungs.

Autopsy. Lungs filled with frothy, watery fluid. Abdomen: Many adhesions about site of transplantation. Right kidney shows no hydronephrosis; no hydroureter (figs. 16 and 17). Left kidney equal in size.

	LENGTH	WIDTH	DEPTH	
	cm.	*cm.*	*cm.*	
Right kidney..	5.5	2.7	2.6	Removed at autopsy, November 18, 1919
Left kidney....	5.0	2.6	2.7	Removed at autopsy, November 18, 1919

Protocol 18

Right ureteroduodenostomy of four hundred and forty-three days' standing, showing late renal atrophy. Dog 21-35. Female, wire-haired terrier, weight, 24 pounds.

October 22, 1920. Right ureteroduodenostomy, Fowler-Coffey method.

October 29, 1921. Blood urea nitrogen, 19 mgm. per 100 cc.; non-protein nitrogen, 38 mgm. per 100 cc.

January 4, 1922. Blood urea nitrogen, 22 mgm. per 100 cc.; non-protein nitrogen, 43 mgm. per 100 cc.

January 7, 1922. Phenolsulphonephthalein, 43 per cent in one hour. Killed with ether. The phenolsulphonephthalein had been given in the lumbar musculature one hour previous to narcosis. None was found in the duodenal contents at autopsy.

Autopsy. Some omental adhesions to abdominal would; otherwise normal except for atrophy of the right kidney, which is very definitely smaller than the normal. The ureteroduodenostomy is perfect. There is no obstruction visible. The ureteral papilla at the point of transplant stands up clearly in the mucosa. When fluid is injected into the lumen of the ureter above it a large stream passes through the papilla into the duodenum. Heart and lungs normal. No other abnormalities noted.

Kidney measurements

	WEIGHT	LENGTH	WIDTH	DEPTH
	grams	*cm.*	*cm.*	*cm.*
Right kidney...	23	5.3	1.95	2.5
Left kidney.....	44	6.0	3.55	3.05

Protocol 19

Right ureteroduodenostomy of three hundred and eighty-one days' standing, showing late renal atrophy. Dog 21-38. Male, spaniel, weight, 20 pounds.

October 28, 1920. Right ureteroduodenostomy.

November 1, 1921. Urine has been slightly bloody for one week.

November 14, 1921. Dog died early this morning.

Autopsy. Rigor is not present. Animal is still warm. Blood in heart not yet clotted. All tissues are bronze in color. Heart and lungs clear. Abdominal content shows no adhesions. There is no loss of peritoneal sheen. The gall bladder is distended but readily empties into the duodenum. The right ureter runs to the duodenum without kinks or obstructions. There are no adhesions about the site of the ureteroduodenostomy. Fluid injected into the renal pelvis flows into the duodenum with great ease. The right kidney pelvis holds about 3 cc. It is almost completely atrophied and shows very great loss of substance but has a smooth sheen to its surface and presents no evidence of scar formation. The left kidney pelvis holds about 3 cc. also. The left ureter is normal and entirely unobstructed. The urine is cloudy and contains many pus cells. The bladder shows a considerable amount of cystitis. The left kidney has many scars in its cortex and is about normal in size. No further abnormalities are noted.

Kidney measurements

	WEIGHT	LENGTH	WIDTH	DEPTH
	grams	*cm.*	*cm.*	*cm.*
Right kidney....	36.8	6.3	2.7	3.65
Left kidney.....	9.8	4.25	1.4	1.5

Protocol 20

Right ureteroduodenostomy of four hundred and nine days' standing, showing late renal atrophy. Dog 21-37. Male, short-haired black mongrel, weight, 24 pounds.

October 25, 1920. Right ureteroduodenostomy.

October 29, 1921. Blood urea nitrogen, 26 mgm. per 100 cc.; nonprotein nitrogen, 50 mgm. per 100 cc.

January 4, 1922. Blood urea nitrogen, 21 mgm. per 100 cc.; nonprotein nitrogen, 39 mgm. per 100 cc.

January 7, 1922. Killed with ether.

Autopsy. The abdominal sheen is normal in appearance. There are no adhesions present. The left kidney is large but normal in all other respects. The right kidney is exceedingly small and almost buried in its fatty capsule. Its ureter is little if any larger than normal

and issues from a small undilated pelvis, which holds about 1.5 cc. of fluid. The duodenal end projects into the duodenum in a mucosa-covered papilla. Fluid can be forced through this papilla with great ease into the duodenum.

Kidney measurements

	WEIGHT	LENGTH	WIDTH	DEPTH
	grams	*cm.*	*cm.*	*cm.*
Right kidney....	5.4	2.7	1.28	1.4
Left kidney.....	39.0	5.6	2.9	2.9

b. The late changes in the two kidneys following ureteroduodenostomy. If an animal with a successful right ureteroduodenal transplant is allowed to live for one or more years, conditions at autopsy are quite different than when it is sacrificed after two to three months. The right kidney will now be found to have undergone marked or even complete atrophy, whereas the left kidney will be in no way dissimilar to that in the previous experiment. In these atrophic right kidneys the evidence of infection and of hydronephrosis is wanting or very slight, although it cannot be said that one or both have not been factors in hastening the late atrophy. That either or both are not the sole factors seems evident. The ureteral opening into the duodenum is patent and normal and there are no kinks or ureteral obstructions discoverable. In figures 19 and 24 are reproduced photographs of the right atrophic and left hypertrophic kidneys four hundred forty-three and four hundred nine days after right ureteroduodenostomy (protocols 18, 19 and 20), and in figures 21, 22 and 26 are shown microphotographs of these atrophic kidneys.

c. Discussion. The explanation of the early hypertrophy of the right kidney following transplantation of the ureter into the duodenum seems obvious. It is burdened with the same double load as its undisturbed mate and it is natural that it should undergo a similar hypertrophy. But the reason for the late atrophy is not so simple. Progressive degeneration from infection or back pressure as the cause is not entirely eliminated by the absence of evidence of either. In a number of the ex-

periments of short-period transplant an imperfect transplant caused hydronephrosis, sometimes of considerable degree, and it is reasonable to suspect this early back pressure as being the cause

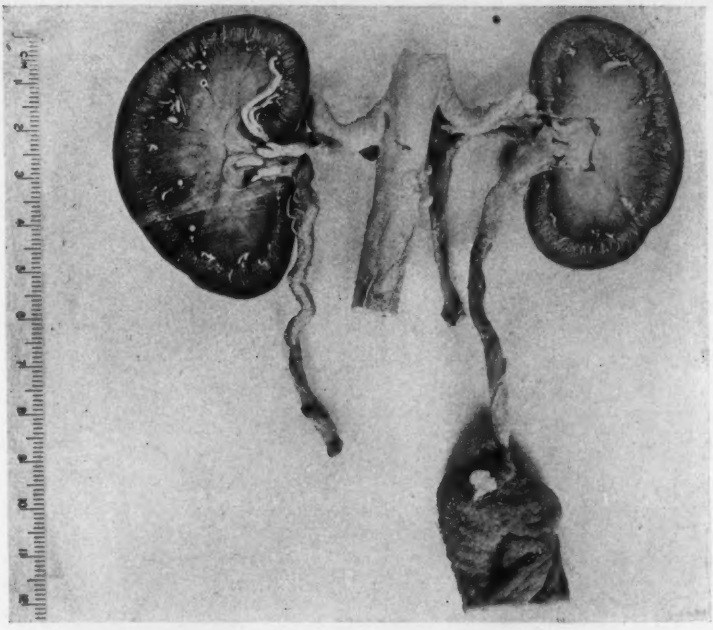


FIG. 18. (Dog 21-35, protocol 17.) Photograph of a beginning late atrophy of the previously hypertrophic right kidney four hundred and forty-three days after right uretero-duodenostomy. The right ureter is not enlarged or dilated and therefore probably never has been. Furthermore ureteral obstruction would be likely to persist if at any time present. The ureteral opening into the duodenum is freely open and is clearly seen in the photograph. The right kidney is definitely smaller than the left hypertrophic one. There is no pelvic dilatation. The cortex and medulla are easily differentiated.

of the late atrophy even when evidence of back pressure at this time is wanting. The marked difference in the histologic appearance of the atrophy of disuse in these kidneys and the degeneration from infection and hydronephrotic atrophy in the others

allays to a certain extent such a reasonable suspicion and constitutes the main support of the correctness of our original assumption that the renal tissue does less and less work and so finally atrophies from disuse. But differences in tissue resistance to the injurious action of even a moderate bacterial toxin over a long

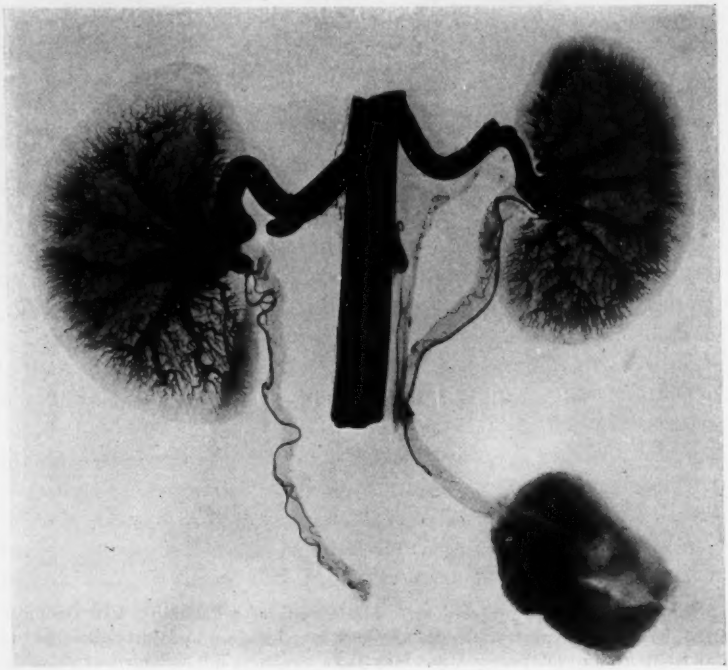


FIG. 19. Photograph of x-ray plate of specimens (Dog 21-35, protocol 17) cut sagittally after arterial injection with barium sulphate. The attenuation of the vascular tree on the right is demonstrated and the ureter does not appear dilated.

period as a necessary sequence to differences in tissue activity and inactivity must not be overlooked and would undoubtedly tend to hasten an atrophy of disuse, if nothing more. The appearance of renal fibrosis in some of these late atrophies and the marked interstitial changes present closely simulate the chronic fibrosis

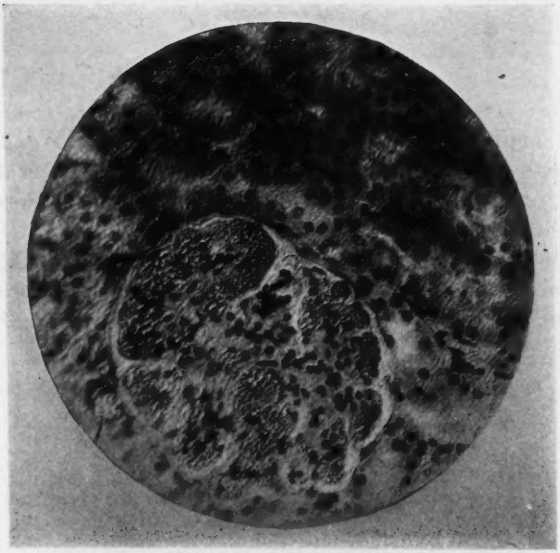


FIG. 20. (Dog 21-35, protocol 17.) Microphotograph (high power) of the hypertrophic left kidney, to be compared to figure 21.

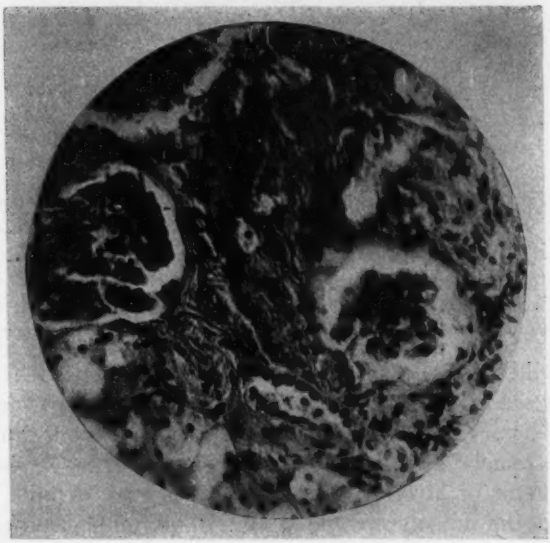


FIG. 21. (Dog. 21-35, protocol 17). Microphotograph (high power) of the late atrophic right kidney, to be compared to figure 20. Shrinkage in the size of cells, interstitial thickening and gnarling of glomeruli are seen.

of old nephritis and arteriosclerotic changes. We therefore hesitate to offer an explanation of the late atrophy after duodenal transplantation. Conditions are not analogous to those in repair hydronephrosis. Competition as a factor is absent. Yet the transplant kidney impresses one as having atrophied more from disuse or diminishing activity than from either back pressure or infection. The almost total destruction that is found in one

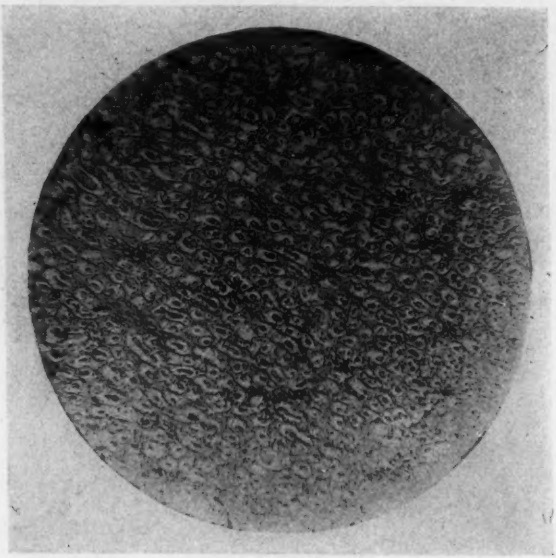


FIG. 22. (Dog 21-38, protocol 18.) Microphotograph of section of right atrophic kidney illustrating marked hyaline degeneration of the tubules.

year would require marked evidence of hydronephrotic atrophy in the one case and of pronounced infection, such as pyonephrosis, in the other. The kidney of dog 21–35, protocol 18 and figure 18 is extremely interesting in this connection as it shows the least amount of atrophy, although this is very definite both in the gross and on microscopic study. The implication of disuse or gradual loss of function as a factor—although it may not be

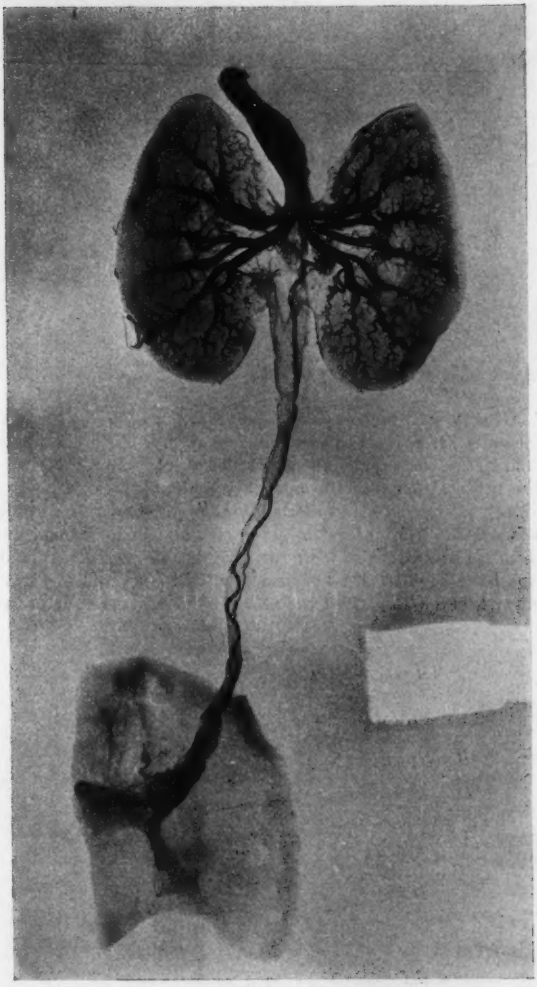


FIG. 23. Photograph of x-ray plate of right kidney (Dog 21-38, protocol 18) cut sagittally after arterial injection with barium sulphate. The shrinkage of bolod vessels is marked.

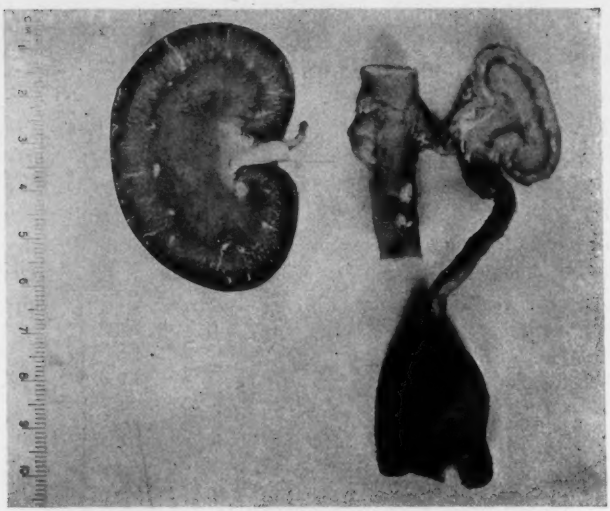


FIG. 24. (Dog 21-37, protocol 19.) Photograph ($\frac{3}{4}$ size) of left and right kidneys 409 days after right ureteroduodenostomy. The left is healthy and hypertrophic. The right side shows evidence of some ureteral dilatation, although the ureteral opening through the duodenal wall is freely patent, but the right kidney is shrunken and markedly atrophic, and this atrophy is totally unlike a degeneration from infection (pyonephrosis) or hydronephrotic atrophy. There is shrinkage in size but with remarkable preservation of kidney shape. Both kidneys have been injected (arterial) with $BaSO_4$ and the left shows rich vascularization whereas the right blood supply is markedly attenuated.

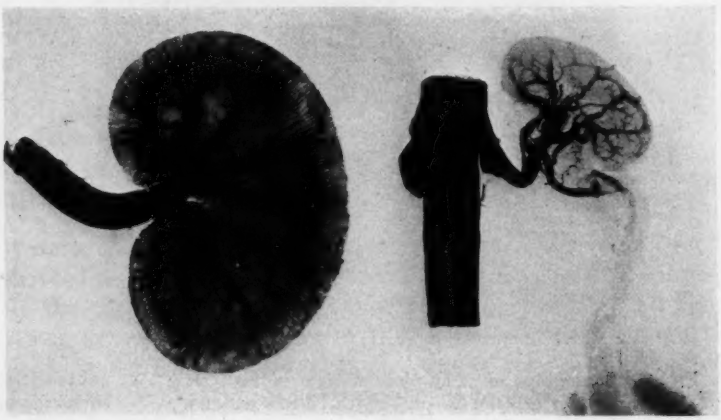


FIG. 25. Photograph of x-ray plate of right (small) and left (large) kidneys (Dog 21-37, protocol 19) cut sagittally after arterial injection with $BaSO_4$. The shrinkage of the arterial system corresponds to that of the parenchyma, both of which are pronounced.

the sole factor—in the late atrophy seems necessary. But how explain the loss of function? How does this kidney learn to work at a slower pace than its divorced fellow? The demand for work would seem to be exactly the same for it as for the undisturbed kidney, inasmuch as they get an equal load in the blood for excretion. Possibly ureteral transplantation is impossible without

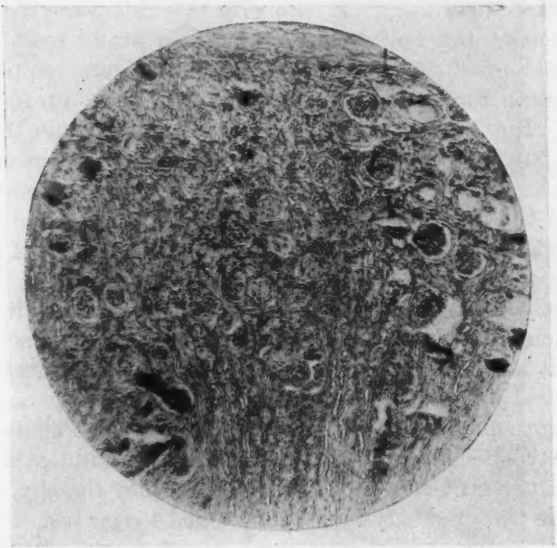


FIG. 26. (Dog 21-37, right kidney.) Microphotograph (low power). Histologic evidence of disuse atrophy, the late atrophy that occurs after ureteroduodenostomy. Marked fibrosis and particularly well marked hyaline degeneration of glomeruli. Tubular system replaced by fibrous strands. Gives the appearance of a chronic fibrosis of Bright's disease.

some renal damage, either by back pressure or infection, and this initial injury puts the transplant kidney qualitatively to a disadvantage. If this were true you would have difficulty in explaining the early compensatory hypertrophy of this transplanted kidney. Compensatory hypertrophy is marked even in those kidneys with definite hydronephrosis from an imperfect

duodenal transplantation. We can think of the following explanation as a probable factor.

Two normal kidneys may be likened to a well paired team of horses. The stay chains of the double-tree may be tightened periodically, first on one side and then on the other, as one or the other opposite member of the team slacks up in pulling the load. But in the course of the day each horse will have done an equal share of the work. So with two kidneys. Work is not continuously and uniformly equal. This would seem to be a well established fact, as first pointed out with emphasis by Albarroan. First one and then the other slacks up for a short period. But the work undone must be finished and the added load is put up to both kidneys equally, so that when measured over a long period they will each have done a proportionate share of the total work. In the experiment with right ureteroduodenal transplantation the two kidneys are put out of balance, and now they cannot be compared to a team of horses. Coöperative competition is removed. The stay chain on the left is continuously strained and whenever the left kidney slacks in its efforts it alone must later make up for its short vacation. It gets no aid from its divorced fellow. Renal work is completely dependent upon it, and it alone. But the stay chain on the right may be slackened with impunity. No additional burden will result to either the right or the left kidney thereby, and the right side will gradually take a longer and longer rest, or will do work less and less efficiently, until it will finally atrophy from disuse. In the earlier periods, however, before left hypertrophy has occurred, the double stimulus in the blood activates the right kidney to a similar degree. It has an ever present demand for more work than it is doing and its functional activity is stimulated to the optimum, so that in consequence it hypertrophies. With the completion of a perfect compensatory hypertrophy on the left side the added stimulus is now removed from the blood and the right kidney begins to suffer from the slow injurious effects of inaction in consequence of normal rest periods, which when prolonged lead to its final and complete atrophy. This idea for the sake of clearness may be diagrammatically represented as in figure 27.

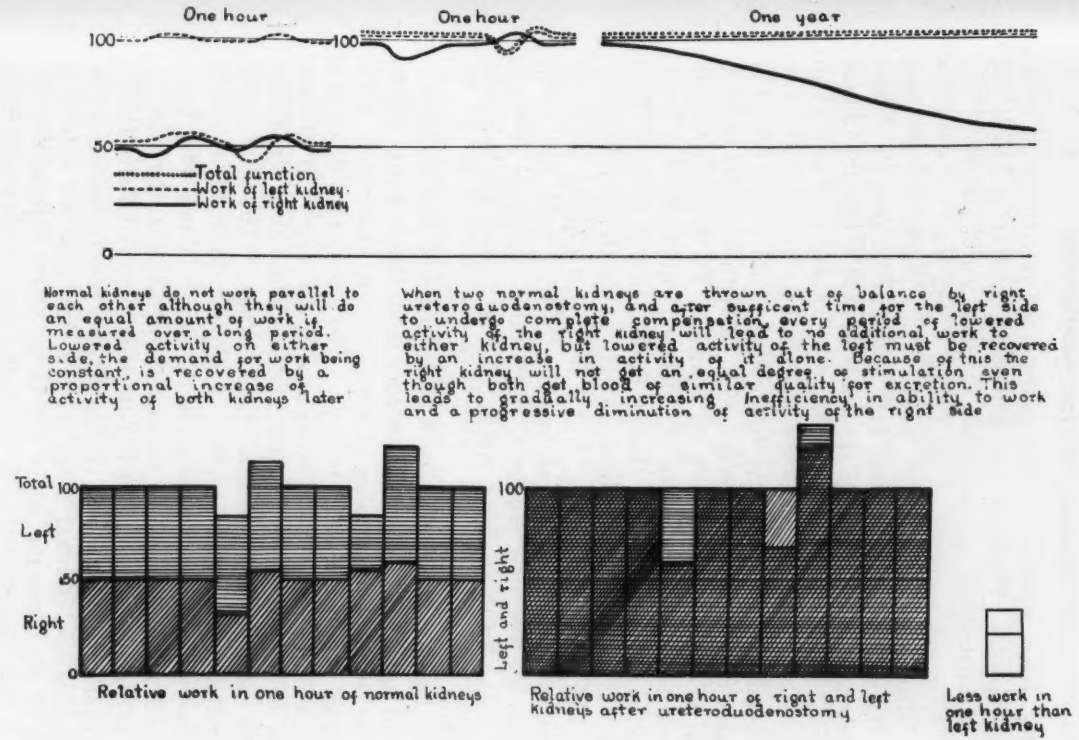

One hour
One hour
One year
100
100
50
0
Total function
Work of left kidney
Work of right kidney
Normal kidneys do not work parallel to each other although they will do an equal amount of work if measured over a long period. Lowered activity on either side, the demand for work being constant, is recovered by a proportional increase of activity of both kidneys later
When two normal kidneys are thrown out of balance by right ureteroduodenostomy, and after sufficient time for the left side to undergo complete compensation, every period of lowered activity of the right kidney will lead to no additional work to either kidney, but lowered activity of the left must be recovered by an increase in activity of it alone. Because of this the right kidney will not get an equal degree of stimulation even though both get blood of similar quality for excretion. This leads to gradually increasing "inefficiency" in ability to work and a progressive diminution of activity of the right side
Total
Left
Right
100
50
0
Relative work in one hour of normal kidneys
100
Left and right
Relative work in one hour of right and left kidneys after ureteroduodenostomy
Less work in one hour than left kidney

FIG. 27. Diagram to illustrate possible explanation of late atrophy after uretero-duodenostomy as largely a disuse atrophy. Competition is indirect though not entirely removed. Injury to the transplanted kidney would create an unequal efficiency. But provided an injury occurred would an unequal variation in function lead to a disuse atrophy?

C. Summary of experimental study

The above experiments demonstrate the occurrence of renal counterbalance, illustrate the difference between a functional and an anatomical compensation in renal work, and show the slow progressive nature of the latter, which may be complete only after many months or years. They emphasize the fact that the anatomical is the only type of counterbalance for serious consideration surgically. In the establishment of this anatomical counterbalance four factors are found to be active, of which two are primary, renal reserve power and renal competition; and two are secondary, compensatory hypertrophy and disuse atrophy.

Renal reserve refers to the potential strength or power of renal tissue to perform more work on demand. Its native or static reserve is limited and when the demand surpasses this limit, hypertrophy to a necessary though limited degree occurs. This ability to hypertrophy on demand may be called the compensatory reserve of renal tissue. But if this compensatory ability is competent the physiological inertia of renal cells will overcompensate and thus acquire a comfortable margin of strength for an occasional overload, which may be termed the acquired reserve.

The usual anatomical division of renal tissue into symmetrical and equal halves and the frequency of unilateral injury signalize the surgical importance of renal reserve. Excretory work and renal supply ordinarily balance. The former considered as a whole is fairly constant but alterations in the supply, by disease, injury or operation, are frequent and the anatomical separation of the renal mass accentuates these changes. The anatomical counterbalance may be relative. Complete destruction on one side has not occurred. Changes in the supply on one side, therefore, will either diminish or increase the demand on the other as well as on itself, since they will both have blood similarly loaded with excretory substances. In the process of establishing a new counterbalance of renal tissue on the right and left side as a result of this alteration there will be an active competition between their relative reserve strengths, which may lead to a

progressive hypertrophy on one side and a regressive atrophy on the other.

When all renal portions on the right and left kidneys have a relatively similar reserve power they will undergo proportional changes in the process of anatomical counterbalance secondary to alterations in the supply or demand. There will be an even reapportionment of functional activity and a coöperative type of anatomical compensation.

When the renal substance that is thrown out of balance has dissimilar reserve power and potential strength, competition renders counterbalance also disproportional, and that side or portion with the bigger and healthier reserve will show the greater compensation, the weaker side gaining little or nothing in functional strength by reason of the increased demand. The stronger side will gradually outstrip the weaker and by compensatory hypertrophy may be so capable of counterbalance as to render the work of its weak assistant unnecessary, disuse atrophy of which will then follow.

Renal counterbalance according to this conception may be represented diagrammatically and in illustration of the four types of animal experiments, as in figure 28, showing the changes in supply and demand and the renal substitutions in consequence.

IV. CLINICAL STUDY

A. Introduction

Anyone at all familiar with renal surgery will recall many opportunities to observe and study renal reserve and compensatory hypertrophy. Experience with polycystic kidneys teaches with how small an amount of renal tissue an individual may live in apparent health. But these kidneys are working to the height of their ability, are unable to hypertrophy and break down when a demand for more work arises. Similar conditions occur in cases of chronic nephritis. It is of interest in this connection to mention the beneficial effect of morcellement in the one case and of decapsulation in the other. Relief of intrarenal pressure in both allows an increased blood supply and a compensatory group hypertrophy to occur, and in consequence an

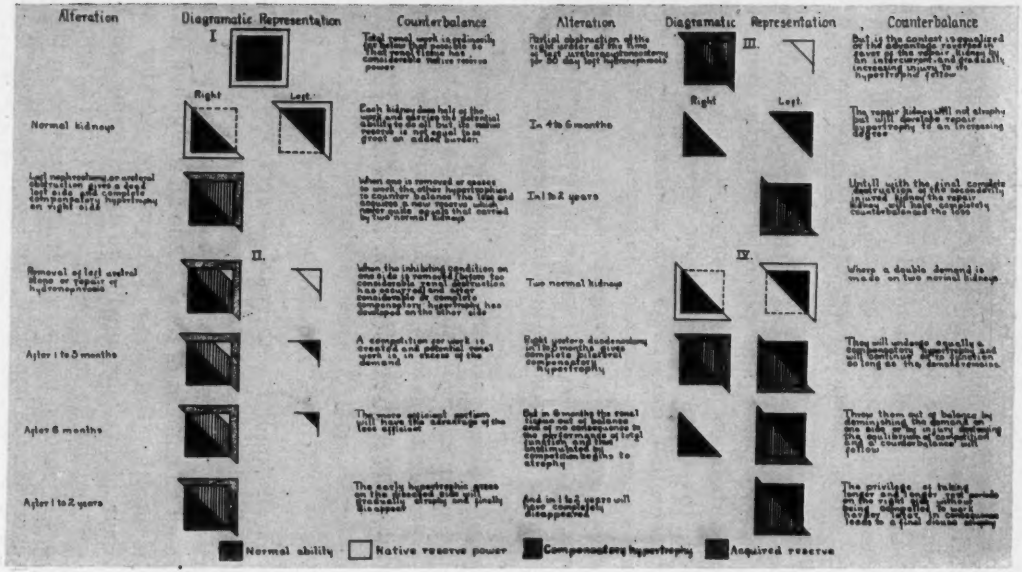


FIG. 28. Diagram to illustrate the several experimental alterations of renal supply and the resultant counterbalance of the remaining renal substance.

improvement in function. Pousson (19) has mentioned this as the more probable explanation of the action of Edebohls' operation than that the kidney circulation is improved by a new capsular blood supply.

The clinical problem in relation to surgery is, first, the determination of the renal reserve and ability to hypertrophy of the respective renal masses, and, where the surgical preservation of tissue is in point, the further determination of the probable action of competition and renal atrophy in the final counterbalance. For relative functional study those tests that put renal tissue under strain would seem to be more valuable in this connection. We lack such a test with ureteral catheterization and have to rely upon a consideration of the pathological processes as best we can determine them, together with the relative functions shown. It will be seen that renal counterbalance, with its factors of reserve and competition, is a much broader basis for the consideration of problems of renal surgery than relative functions alone, since it presupposes an attempted foreknowledge of the final result.

V. REPORT OF CORES

When an attempt is made to apply these principles clinically the confusion between a functional and an anatomical counterbalance is irremediable in view of inability to correlate functional findings with anatomical conditions. We have no renal tests that denote renal reserve and cannot distinguish the degree or even existence of native, compensatory or acquire reserve power. But from operative findings, material and results many clinical examples of the process of compensation as well as of competition may be collected.

Case 1. P. C. 609. Male, age twenty-two. Referred by Dr. H. W. Allen.

Complaint. Renal colic, passage of gravel.

Family history. Mother living and well; age fifty. While she was pregnant with patient she had attacks of colic, after which she passed blood in urine. Father has high blood pressure. Brothers (two), one sent to Arizona for possible tuberculosis; one sick with fever for a long

time. Living sister had a facial paralysis, age twenty-one; cleared in a few weeks. No miscarriages in family. Grandmother died of tuberculosis; spent winters with patient's family when he was young. Grandfather died of heart trouble. Aunt had a tumor of uterus.

Past history. Negative.

Diseases: Chicken-pox, mumps, measles. Tonsilitis and sore throats almost continuously five to six years ago. Erysipelas 1913, from which present illness began. Otitis media.

Accidents: Left arm broken. Sprained right wrist.

Operations: Tonsillectomy. Still gets sore throats, less severe.

Habits: Negative.

Past illness. Sore throat 1913, three days later erysipelas in face, which became chronic. Second severe attack two months later, at which time had optic nerve inflammation. Streptococcus vaccine. Albumin in urine; no crystals. In 1915, had first attack of colic; awakened with severe cramp over scrotum. Three months later second attack, gradually increasing to climax, with vomiting, sweating, cramp in toes. No chill; lasted three to ten hours. Left quickly; soreness remained in back. Other attacks November, February, May, August, free for nine months, to July, 1917. Doctor found swelling and tenderness in upper lumbar region on left. At present patient has no complaints. Is feeling perfectly healthy, has had no pains except occasionally all his joints hurt and are tender to touch. No swelling, fever or redness. His hands and feet perspire a great deal.

Central nervous system. Severe headaches back of eye, nausea relieved by vomiting.

Cardiac respiratory. Sore throats. Dr. Moffitt found heart murmur. Blood pressure 140.

Gastroin testinal. Negative.

Genito-urinary. Noted. For nine years, has had periods of frequency and sensation as if not finished, occasional burning on urination, which soon passes away. No pain; slight increased frequency daily. Nocturia once in early morning just before arising. Urinary, otherwise negative.

Physical examination. General negative.

Abdomen: Flat tympanitic, soft. No masses; no tenderness.

Kidneys: Both kidneys palpable; the right is felt down to the level of umbilicus. Left not so distinctly felt. Spleen not felt.

Genitalia: Left complete inguinal hernia. Contains intestines. Ring admits two fingers. Also left varicocele. Patient has a slight

itching eczema in groins around scrotum and anus. Flat, reddened in color.

Extremities: Negative reflexes:	*R.*	*C.*
Patellar	+	+
Achilles	+	+
Babinski	−	−

December 21, 1917. Phthalein: First, 40; second, 15; total, 55 per cent. Wassermann, negative. Complement fixation of blood for tuberculosis, weak +.

December 25, 1917. Severe pain in right kidney region, radiating down to groin. Tenderness to pressure.

December 29, 1917. *Cystoscopy:* Left ureter dilated. Phthalein intervenous.

First fifteen minutes, right transvesically.

Appearance time, two minutes. 15%. Left, trace.

X-ray: Left uretero-pyelogram taken with thorium nitrate (fig. 29). Dilated pelvis of kidney and ureter. Major calyces large and bulbous. Minor calyces obliterated. Dilated ureter describes an S-figure. Following pyelography patient had severe reaction with partial anuria and jaundice, probably due to infectious cholangitis. The seriousness of the anuria and renal disturbance is graphically shown by the following blood retention and phthalein tests:

January 4, 1918. Urea nitrogen, 168.
January 15, 1918. Urea nitrogen, 165.
January 16, 1918. Urea nitrogen, 200.
January 17, 1918. Urea nitrogen, 214.
January 18, 1918. Urea nitrogen, 144.
January 21, 1918. Urea nitrogen, 140.
January 23, 1918. Urea nitrogen, 112.
January 25, 1918. Urea nitrogen, 119.
February 1, 1918. Urea nitrogen, 16.

January 22, 1918. Phthalein intramuscularly, first, 1; second, 4; total, 5.

January 25, 1918. Phthalein intramuscularly, first, 1; second, 4; total, 5.

January 29, 1918. Phthalein intramuscularly, first, 11; second, 7; total, 18.

February 1, 1918. Phthalein intramuscularly, first, 11; second, 7; total, 18.

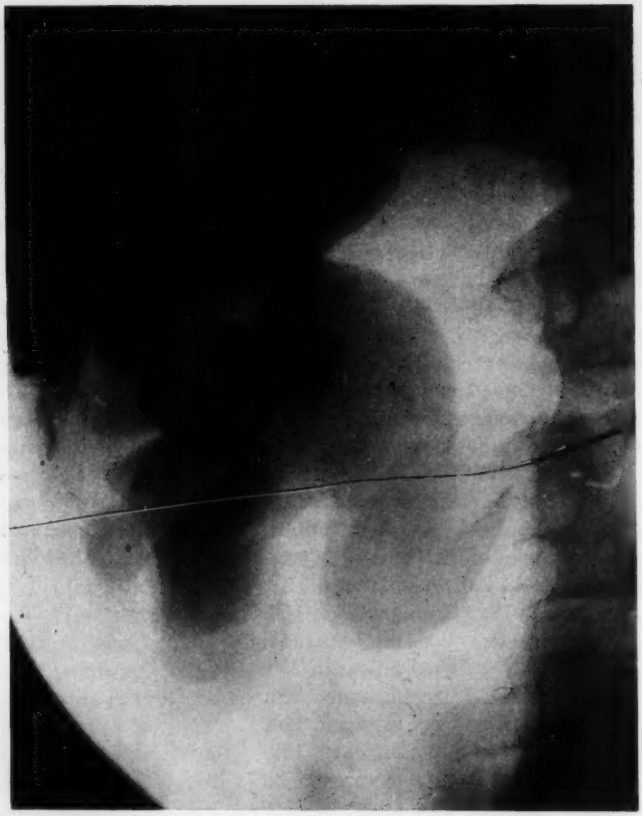


FIG. 29. The degree of hydronephrosis in this pyelogram is so apparent that attempts of conservation would seem absolutely hopeless. This is true provided the opposite kidney is healthy and compensatory. But when there is a distinct demand for even this badly diseased renal tissue to do its utmost, as in cases 6 and 7, figures 37 and 38, conservation may give most surprising and wonderful results.

February 3, 1918. Phthalein intramuscularly, first, 13; second, 8; total, 21.

February 7, 1918. Phthalein intramuscularly, first, 14; second, 14; total, 28.

April 10, 1918. Phthalein intramuscularly, first, 35; second, 25; total, 60.

January 10, 1918. Urine: Staphylococcus albus. Guinea-pig did not die. Urine 1009, albumin. H. T., many pus and epithelial cells. Blood pressure, 120–80. Stool benzidine, +.

January 16, 1918. Eye examination: M. M. 0^2 congested; slight mucoid discharge. Blood vessels full and nerve head and retina slightly hyperemic. Otherwise negative.

September 20, 1918. Cystoscopy: Kidney findings:

Right	*Left*	*Transvesical*
0 R. B. C.	10 qhd.	0
0 W. B. C.	60–75 qhd.	Very many
0 Casts	0	0
Few epithel.	Few	Few
0 Organ.	0	0

Cultures: Taken of bladder and right and left kidney, search for tubercle bacilli and guinea pig inoculation.

Cultures taken of urine (September 20):

Bladder: Growth (B. fecalis alk.).

Right kidney: No growth.

Left kidney: Growth (staphylococcus albus).

No organisms microscopically; no acid fast bacilli. Guinea-pigs were inoculated.

Discharged: Left hydronephrosis. To return for nephrectomy.

October 25, 1919. Readmitted. Cystoscopy postponed. Condition: Same.

October 28, 1919. Readmitted. Cystoscopy: Kidney findings:

Right	*Left*	*Transvesical*
Numerous R. B. C.	Not obtainable	Rare
1 q 3 hd. W. B. C.	Catheter plugged	100 qhd.
0 casts		0
Few epithel.		Rare
0 organisms		0

Cultures: Bladder, right kidney, left kidney.

Phthalein: Right, 3½ appearance time. 25 cc., 20 per cent, first fifteen minutes; 60 cc., 10 per cent second fifteen minutes; 30 per cent total, Left, 10 per cent, 20 cc.

Leakage: 50 cc., 20 per cent phthalein.

Pyelography: Taken of right kidney shows large and normal pelvic outline.

Remarks: Phthalein, October 22: First, 90 cc., 24 per cent; second, 150 cc., 12 per cent; total, 36 per cent. October 25: First, 200 cc., 20 per cent; second, 275 cc., 15 per cent; total, 35 per cent.

October 29, 1919. Discharged.

November 22, 1919. Readmitted. Left ureter dilated with ureteral catheter; 560 cc. urine removed through this catheter, coming spontaneously in fast drops; a continuous stream obtained on pressure over the ureter of this side. Urine from left kidney shows few red blood cells and pus cells; rare epithelial cells; no organisms or casts.

November 24, 1919. Discharged. *Diagnosis:* Left hydronephrosis. Hydroureter with stricture.

December 18, 1919. Readmitted. Cystoscopy: Kidney findings:

Right not catheterized	*Left*	*Transvesical*
Red blood cells	Did not run	0
White blood cells		6 qhd.
Casts		0
Epithelial cells		2 qhd.
Organisms		0

Phthalein: Voided specimen at end of one-half hour; transvesical, 50 per cent.

Remarks: Impossible to pass any filaform or catheter beyond strictured area about 6 cm. above left ureteral meatus. No. 7 catheter passed to this point and left in for collection of specimen.

December 19, 1919. Discharged. Not relieved.

January 6, 1920. Readmitted. Cystoscopy: Kidney findings:

Right	*Left*	*Transversial*
Red blood cells	Abundant	Abundant
White blood cells	1–2 per h.d.	Clumped 1–2 per h.d.
Casts	0	0
Epithelial cells	0	0
Organisms	0	0

	Right
Phthalein:	
Appearance time	3
First fifteen minutes	25
Second fifteen minutes	10
Total	38

Leakage: At the end of thirty minutes, 12.5 per cent.

January 7, 1920. Discharged. Condition: Same.

January 26, 1920. Readmitted. Urine: Specific gravity 18; albumin F. P. T.; sugar 0; white blood cells and red blood cells, 1 per h.d., epithelial cells many, organisms 0. Phthalein intramuscular: First, 50 per cent; second 7.5 per cent; total, 57.5 per cent.

January 29, 1920. *Operation.* Left nephrectomy for hydronephrosis

General condition: Fair.

Operation: Gas and oxygen anesthesia. The skin was prepared with alcohol, ether and biniodid. An incision about 12 cm. long was made parallel to and just below the costal margin, extending from the costovertebral angle toward the umbilicus. The lumbar and lateral abdominal muscles were divided down to and exposing the perirenal fatty capsule of the kidney. There were numerous adhesions about the kidney which was somewhat enlarged. The kidney was separated from its fossa with little difficulty. The various adhesions to it were separated by sharp dissection after being tied with no. 1 chromic catgut. The vessels at the hilus of the kidney were next identified as well as the ureter. A string tape was placed under the ureter and with traction on this the ureter was held up out of the wound. The ureter was cut about 3 cm. below the kidney pelvis, its distal end being tied off with no. 2 chromic catgut. Three large Ferguson kidney clamps were applied to the renal vessels, after which the kidney was cut between two of these clamps. No. 3 chromic ligatures were used to tie off the renal vessels, the Ferguson clamps being successively removed. There was no subsequent hemorrhage. The deep fascia was approximated with running chromic sutures, the subcuticular tissue with no. 1 plain catgut and the skin with black silk and two silk-worm gut retention sutures. Fluff dressings applied.

Condition of patient on leaving operation room: Good.

Specimen consists of kidney preserved in 10 per cent formalin, dimensions 11 x 5.5 x 5 cm., approximately normal in size and shape

except for hilus, which is not of normal thickness. The specimen includes about 2 cm. of the first part of the ureter. The capsule is readily stripped from the cortex, except over a few scar-like depressions where it is adherent, and discolored as if slight hemorrhage had occurred here. Radiating from these areas are minute vessels which appear congested and exhibit punctate extravasations along their courses.

The surface of the kidney appears pale, and exhibits a slight degree of lobulation, and in addition the scar-like depressions already noted suggesting underlying pathology.

On section, the cortex appears approximately normal in thickness (0.6 cm.) and its architecture not distorted except for yellowish white areas underlying the superficial scar-like areas and extending all the way through the parenchyma. They resemble infarcts. They are too yellow to be pure fibrous tissue. They are not wedge shaped. The Bowman's capsules are easily seen. In one area only the cortex is slightly infringed upon by a markedly distended calyx. The medulla has been practically obliterated by a chronic hydronephrosis and pyramids markedly distorted. The renal pelvis and major and minor calyces are tremendously distended. The pelvis and ureteral wall are thickened and there is apparently some constriction at the junction of pelvis and ureter. The lining membrane of the ureter is thrown into folds. The membrane of the pelvis presents a greyish white minutely granular appearance, and a few reddish brown spots which are probably either areas of vascular congestion or extravasation.

The kidney was photographed and sections taken from representative areas; one of capsule, parenchyma and wall of distended calyx, and the other of the wall of the pelvis, including proximal portion of ureter with point of constriction.

Microscopic section (consisting of capsule, parenchyma, and wall of distended calyx) shows the following: The capsule is frayed out and somewhat edematous looking. Over the scarred depressions of the cortex the capsule is adherent and the capillaries appear full but not definitely engorged. There is some hemorrhagic extravasation in the capsule, which is probably of mechanical origin.

The yellowish white areas noted in the gross, which compose about a third of the section are seen to consist of dense peritubular infiltration with lymphocytes and connective tissue cells, and changes so marked in the tubules and glomerulus showing partial or complete hyalin transformation. These areas, therefore, consist almost entirely of lymphocytes and connective tissue.

The parenchyma between these yellowish white areas present various abnormal changes. The glomeruli present various changes from normal to complete hyalin transformation. Many of them are so swollen by hyaline changes that the capsule and tuft are in close apposition. In some the space between tuft and capsule is filled with gelatinous or hyalin looking material and there is considerable connective tissue thickening around many of the capsules. The epithelium of the tubules shows cloudy swelling and vacuolization throughout the whole section. Many are filled with hyalin-looking material.

Throughout the section are seen great number of large phagocytic cells and foreign body giant cells, which are grouped about a slightly granular basophilic substance occupying the lumen of the tubules, especially in the scarred areas, even out to the cortex of the kidney. A few of these phagocytic cells are present in the capsule. Whether these cells are transformed cells from the tubular epithelium or wandering cells of connective tissue origin is not clear, but they give the impression of having originated from the tubular epithelium. Cross section of some of the tubules presents, in place of their normal epithelial lining, a lining of these phagocytic cells morphologically similar to the normal epithelial cells, thus strongly suggesting an epithelial origin. A pyelogram had been taken in the hospital and this basophilic material probably represented thorium (?) salts which had been injected in the pelvis for the roentgenographic purposes. The epithelial lining of the pelvis shows a moderate degree of degeneration and is infiltrated by a few lymphocytes and occasional neutrophiles. The submucosa exhibits a moderate degree of lymphocytic infiltration.

The ureter is thickened. The mucosa appears normal. The submucosa shows slight lymphocytic infiltration, also fairly numerous basophilic phagocytic cells like those described above.

Diagnosis: Chronic phylonephritis with foreign body giant cell reaction (probably due to thorium salts). (Dr. G. I. Rusk.)

January 30, 1920. Patient very restless. Aches all over, particularly back and right side. Vomited about 200 cc. clear liquid. Abdominal pain relieved by enema.

February 2, 1920. Wound in excellent condition.

February 6, 1920. Phthalein: First, 60 per cent; second, 10 per cent; total, 70 per cent.

February 8, 1920. Patient feeling well; no pain, no discomfort. Urine contains acid, sugar 0; albumin 0; sediment, few white blood cells and urates.

February 9, 1920. Small discharge of degenerated blood from lower angle of wound today. Examination of wound shows no opening or evidence of infection.

February 10, 1920. Urinalysis, acid, sugar 0; albumin 0; sediment, few white blood cells.

February 11, 1920. *Diagnosis:* Left hydroureter. Left hydronephrosis.

Condition: Markedly improved.

April 14, 1922. This patient has been under observation continuously since discharge from hospital. Repeated functional tests show maintenance of perfectly normal function.

Discussion. Case 1 is an example of the degree of inhibition that disease on one side may exert upon a perfectly capable and healthy partner. The period of serious renal insufficiency following pyelography further emphasizes this interrelationship. The pathologic findings of foreign body giant cells as a probable reaction from thorium used at pyelography is of interest from another standpoint. The quick and complete compensatory hypertrophy following removal of the inhibiting factor by nephrectomy is striking.

Case 2. P. C. 1528. Male, age forty-seven. Referred by Dr. H. C. Moffitt.

Complaint. Abdominal trouble; flat stools; burning and frequency of urination; dizziness when changes position quickly.

Family history. Father died at fifty-nine, rupture of intestines; mother living and well; two sisters living and well; one sister died in infancy. Not married. No family diseases.

Past history. Diseases: Mumps, measles, typhoid malaria, ill six weeks; rheumatism slightly. Appendectomy three years ago for chronic appendicitis.

Venereal denied.

Habits: Coffee 2 daily; tea 2 daily; no alcohol or tobacco.

Sleeps fairly well. Nycturia once often. Bowels constipated; takes physic.

Past illness. As a youngster occasionally had severe stomach-aches and was constipated. Eight years ago developed a severe belly-ache with nausea and vomiting. Had very frequent urination. Could only pass a drop at a time and it smarted. Some fever. Pain seemed to

radiate to bladder. Had passed some high colored urine previously, at one time almost blood red but this had been passed a year or two before he had pain. In this first attack he had to be taken to Alameda Hospital where he stayed five days and gradually recovered. Occasionally had slight pain in stomach after this. Often had a backache in lumbar region. Three years ago another severe attack—no trouble with urine this time. Pain developed this time over appendix and then went away for two days, finally returning. Pain very acute, nausea and vomiting, etc. Appendix removed by Dr. Endlow of Chicago. Appendix long and kinked, in region of kidney. Recovered well and gained weight. A few months later had typhoid-malaria. No similar attacks, not so bad, but since often gets slight pains in right lower quadrant. Has some frequent back pain in lumbar region but no radiation to bladder. Bladder has been irritable since, often urine stings and burns and he passes it frequently. No pain radiating to bladder. Occasionally little sticky pain in lower abdomen—pressure in lower abdomen; belches a good deal; no good appetite. Occasionally sour stomach but very little. No vomiting. No mucous in throat. Dizziness bothers him very little; change of position quickly makes him feel queer.

Urine: February 11, 1920: 1020, acid, yellow, cloudy, a trace of albumen, no sugar; sediment, amorphous urates, a large number of pus cells, occasional red blood cell; rare epithelial cell.

Urine: February 11, 1920; Sediment, large number of pus cells; amorphous urates, occasional red blood cell, rare epithelial cell.

Stool: February 11, 1920: Dark brown, solid, formed stool; no parasites or ova; Benzidin negative, starch negative.

Physical examination. Tall, fairly well developed and nourished man. Hair thin, body hair normal. Skin clear.

Eyes: Pupils irregular and small. React sluggishly to light and accommodation. Eyes set in. Eye muscles negative.

Nose: Negative.

Tongue: Pretty clean. Teeth show a lot of dental work, gums in fair shape.

Tonsils: Red and ragged. No general glandular enlargement.

Thyroid: Negative.

Chest: Well formed.

Lungs: Negative.

Heart: Not enlarged, respiratory arrhythmia. Arteries palpable.

Blood pressure: 125/80.

Abdomen: Level and soft. Liver and spleen not felt. Scar of old appendectomy well healed. There is a little bulging below scar as from moderate relaxation of wall. Cecum palpable. No especial tenderness. No hernia, no rigidity.

Genitalia: Left varicocele; otherwise negative.

Extremities: No tremor; no edema or scars. No joint changes. Hands cold and moist. Reflexes equal and active.

Spine: Straight; slightly stiff in lumbar region with a little pain on bending and twisting in this region. Nothing definitely wrong with sacroiliacs.

Impression: Probable adhesions about scar of appendectomy. Slight hypertrophic arthritis of lumbar sacral region.

Wassermann: February 17, 1920, negative.

Gastric analysis: February 17, 1920:

	HCl	*Total*	
Fasting	0	18	Fasting content about 30 cc., mucoid opalescent; material; Benzidin. negative Starch negative
I	25	63	
II	14	60	
III	24	84	
IV	30	42	
V	20	55	
VI	30	105	
VII	55	120	

Teeth: February 19, 1920: Superior left first bicuspid—large area of rarefaction probably result of infectious process.

Inflammatory rheumatism age eight.

Examination (Dr. Moffitt): Arteries a little softer than recorded. Has a good deal of cramping in legs at night, more on the left. Nothing suggesting lightning pains. Veins right upper arm more prominent than left.

Three-glass test—Urine: February 21, 1920: All three glasses cloudy throughout; one or two containing floculent ppt. Sediment 1, large number of pus cells; amorphous urates; several red blood cells; sediment 3, large number of pus cells; amorphousurates; several red blood cells; a trace of albumen.

February 18, 1920. *X-ray:* Gastrointestinal: The lung fields are clear. The heart and arch are negative. There is no delay in the esophagus.

Stomach good tone and position; freely movable; no defects outline. Moderate peristalsis. Pylorus and cap are well outlined. At six hours:

There is no gastric residue. The six-hour meal is in the ileum and ascending colon which are movable as a mass.

Loops of the ileum are not separable from the cecum, and are slightly tender. At nine hours: The meal is in the cecum, ascending and transverse colon. At twenty-four hours: The meal is well distributed through the colon which shows no obvious defect.

Conclusion: Adhesions about the terminal ileum and cecum.

February 25, 1920. *X-ray:* Kidneys, ureters, bladder. There is an irregular calcified shadow in the region of the upper pole of the left kidney. The left kidney is enlarged and low. The right kidney is low but not enlarged. There is also a small rounded shadow on the right side at the region of the junction of the ureter with the pelvis of the kidney, which is probably a stone in the right ureter. The fourth lumbar vertebra on the right shows an irregularity of the superior border, which has the appearance of an old fracture. There is also a small rounded exostosis on the superior border of the third and fourth lumbar vertebrae on the left side.

March 2, 1920. *Bladder:* Red blood cells 0; white blood cells 7 every h.d.; epithelial cells 3 every h.d. Casts 0.

Left kidney: Epithelial cells 8 every h.d.; red blood cells 20 every h.d.; white blood cells 7 every h.d. Casts 1 granular.

Right kidney: Not running.

March 4, 1920. Waxed tipped catheter passed well into left ureter. No scratches obtained. Left lower end of ureter dilated with no. 6 catheter. Catheter halfway up right ureter for urine study and transvesical phthalein. No flow so phthalein not done.

March 23, 1920. Phthalein: First hour, 20 per cent; second hour, 20 per cent; total, 40 per cent.

March 24, 1920. Urine: Specific gravity 1025; acid reaction; very slight trace albumen; white blood cells abundant; red blood cells occasional; epithelial cells +; casts 0; organisms 0.

Cultures of bladder and left kidney showed Staphylococcus albus.

Right kidney, not running.

X-ray: Same as at previous entry. Irregular calcified shadow in region of upper pole of left kidney. Small rounded shadow on the right side at junction of ureter with pelvis of kidney.

March 25, 1920. *Note by Dr. Kruse.* Dr. Hinman finds a stone in the right ureter which is shown by the last x-ray just at the tip of the catheter, completely obstructing the ureter. He dilated the ureter once and tried to get the stone out but failed. He thinks that Satur-

day a dilatation should be made again in an effort to get the stone from below. Failing this, he recommends operation for removal of this stone the following week, as the kidney is apparently nearly completely blocked off on that side. X-rays and pyelogram of the left kidney show the stone in the upper pole. Some pus was drained from this side. Total phthalein 40 per cent. Dr. Hinman thinks the left kidney will have to be operated for removal of this stone.

March 25, 1920. In view of the complete blocking of the right ureter and the probability that the right kidney function was much decreased, it would seem wiser to remove the calculus from the left kidney, first unless the stone from the right ureter can be removed under papavarinum and dilatation (note by Dr. H. C. Moffitt).

March 29, 1920. Readmitted.

April 1, 1920. Patient has been passing "smoky" urine since March 29. Urine is clearer than this morning. No pain.

Cystoscopy: Kidney findings:

	Right	*Left*	*Transvesical*
Red blood cells		0	22–24 qhd.
White blood cells		3–4 qhd.	Abundant
Casts		0	0
Epithelial cells		Many	3–4 qhd.
Organisms		0	0

Cultures: Bladder.

Phthalein:

Appearance time, urine collected, five and one-half minutes.

First fifteen minutes, transvesically, twenty minutes.

Second fifteen minutes, bladder catheterized at twenty-five minutes.

Total, end of thirty-minute period forty-five minutes; trace.

Leakage, only trace of phthalein.

April 2, 1920. Slight pain in left kidney region this morning.

April 4, 1920. Culture: Staphylococcus albus.

April 6, 1920. *Operation:* General condition: Excellent.

Reason for operation: Stone in right ureter, junction of middle and lower third.

Gas and oxygen anesthesia. The field of operation was prepared with alcohol, ether and biniodid. A small elliptical incision was made about 2 cm. mesial to the right superior iliac crest, a little farther lateral than it would be done for appendectomy. The fascia of the external oblique was med. and divided in the direction of its fibers.

The muscular attachments of the internal oblique and transversalis muscles were next cut through close to the iliac crest so as to give exposure down to the peritoneum. This was not opened but was dissected off from the iliac crest and superior iliac fossa so as to give an approach to the right ureter by the extraperitoneal route. By using deep blade retractors the muscles and peritoneum were divided so as to expose the iliac artery and vein as well as the right ureter in the region of the right sacro-iliac synchondrosis. The ureter was identified and a string tape pad passed around it. The stone was about 3 cm. above the brim of the pelvis. It was easily palpable and was milked down toward the bladder for about 2 cm. so as to be more accessible. The ureter over it was opened for about 1 cm., allowing the stone to be extracted. An attempt at dilatation of the ureter above was not successful although a filiform could be passed up to the kidney pelvis, but a later ureteral catheter could not. The ureter was freed below this point, giving passage of the catheter into the bladder without difficulty. The ureter was closed with no. 0 iodized catgut. A small tube drain was passed down to the site of operation for drainage and brought out in the groin through a stab wound. The wound was completely closed, the muscles, internal oblique and transversalis being sutured with chromic uninterrupted; the fascia of the external oblique was sewed as in a hernioplasty, and the skin was closed with uninterrupted silk. No silkworm gut sutures were used.

Condition of patient on leaving operating room: Good.

April 9, 1920. Considerable gas pain but is now comfortable.

April 12, 1920. Urine: Yellow, cloudy, acid, sugar 0, albumen faint trace, sediment red blood cells 4–6 qhd.; white blood cells 60–70 qhd.; epithelial cells +; casts 0; organisms 0.

April 13, 1920. Skin sutures removed. Considerable serosanguineous oozing from middle of wound.

April 14, 1920. Phthalein: First hour, 45 per cent; second hour, 15 per cent; total, 60 per cent.

April 15, 1920. *Cystoscopy:* Kidney findings:

	Right	*Left*	*Transvesical*
Red blood cells	50–65 qhd.	Not taken	6–8 qhd.
White blood cells	10–12 qhd.		20–25 qhd.
Casts	0		0
Epithelial cells	Few		2–3 qhd.
Organisms	Cocci +		0

Cultures: Bladder, right kidney and left kidney—All Staphylococcus albus.

April 15, 1920. *Culture:* Bladder, right kidney, left kidney—Staphylococcus albus.

April 20, 1920. *Cystoscopy:* Kidney findings:

	Right	*Left*	*Transvesical*
Red blood cells			0
White blood cells			Clumps
Casts			0
Epithelial cells			Few
Organisms			0

Remarks: Right side easily catheterized. No urine obtained. No retention in kidney pelvis. Catheter open and when injected, the fluid came back free. X-ray pyelogram right kidney shows markedly distorted pelvis, major calices much elongated; minor calices blunt and dilated; ureter not dilated.

April 22, 1920. Phthalein: First hour, 35 per cent; second hour, 20 per cent; total, 55 per cent.

Urine: Clear, light yellow; sugar 0; albumen F. P. T.; sediment; red blood cells 0; white blood cells 6–8 qhd., epithelial cells few, casts 0; organisms 0.

April 24, 1920. *Discharged.*

August 16, 1920. Readmitted: Radiograms show one large and about three small stones in upper portion of the left kidney.

August 17, 1920. *Cystoscopy:* Kidney findings:

	Right	*Left*	*Transvesical*
Red blood cells.....	0	25–30	2–3
White blood cells.....	0	5–6	40–50
Casts.....	0	0	0
Epithelial cells.....	0	0	0
Organisms.....	None seen	None seen	Few cocci

Cultures: Bladder, right kidney and left kidney.

Phthalein: Appearance time, 0 cc., two and one-half minutes; first fifteen minutes, 0 cc., 15 per cent; second fifteen minutes, 0 cc., 10 per cent; total, 0 cc., 25 per cent.

Leakage slight, 5 cc., less than 2.5 per cent.

X-ray reports: August 13, pelvis incompletely filled. August 14, multiple areas of calcification in region of right kidney which have appeared since first x-ray plates of February 25, 1920.

August 18, 1920. Phthalein: First hour, 20 per cent; second hour, 7.5 per cent; total 27.5 per cent, two-hour specimen.

Mouth, gums, throat in satisfactory condition.

Heart: Negative.

Blood pressure, 118/85.

August 19, 1920. Phthalein: First, 40 per cent; second, 25 per cent; total, 65 per cent.

Culture: Bladder, Staphylococcus albus; left kidney, Staphylococcus albus; right kidney, sterile.

August 21, 1920. *Operation.* General condition: Good.

Reason for operation: Calculi in the upper portion of the pelvis of the left kidney.

Gas and oxygen anesthesia. The field of operation was prepared with alcohol, ether and biniodid. An incision about 15 cm. long, parallel to and just below the last rib, was made and carried down to the muscle tissue, bleeding points being caught and ligatured with no. 00 chromic. The muscles between this region and the kidney were incised and the perirenal fat was exposed. By blunt dissection with the finger the fat was pulled from about the kidney and it was completely cleaned off and its pedicle isolated. A strong no. 24 soft rubber catheter was placed about the kidney; the catheter was tightened about the kidney pedicle to cut off the blood supply for a few minutes. A flat curved needle threaded with silver wire was passed through the middle of the kidney in its upper pole and by means of a sawing movement, the upper pole of the kidney was split in half in its least vascular portion. The incision was carried down into the upper portion of the pelvis, of the kidney. Five calculi varying in size from about 3 mm. to 1 cm. were removed from the upper portion of the pelvis. At frequent intervals traction was loosened on the catheter, allowing the blood to flow through the kidney a little. The halves of the upper pole of the kidney were now approximated and sutured by means of five mattress sutures of no. 2 chromic. The catheter was removed from the pedicle of the kidney. No bleeding from the kidney occurred. The kidney was placed in its original position. The portion of the perirenal fat was spread out over it again. The deepest fascia was approximated with interrupted sutures of no. 2 chronic catgut. The deep muscle layer was approximated with mattressed sutures of no. 2 chronic catgut, the superficial muscles and fascia were closed with a continuous locked stitch of the same material. A gauze strip pack which had been placed at the lower pole of the kidney was left in. The skin was closed with

continuous locked stitch of black silk except at the lower pole of the incision where the tip of the drain protruded.

Condition of patient on leaving operating room: Good.

August 25, 1920. Blood: Urea nitrogen, 40 mgm. per 100 cc.; non-protein nitrogen, 66 mgm. per 100 cc.; creatinine, 2.09 mgm. per 100 cc.

Blood pressure: 124/74.

August 26, 1920. Blood pressure: 121/76. Frontal sinusitis still persists. Wound considerably reddened.

August 27, 1920. Blood pressure 119/80. Wound draining considerable sero-purulent discharge.

Culture: Staphylococcus albus.

August 28, 1920. Blood: Urea nitrogen, 29.0 mgm. per 100 cc.; non-protein nitrogen, 59.0 mgm. per 100 cc.

August 30, 1920. *Culture:* Staphylococcus aurens. Wound very painful yesterday but much better today.

September 6, 1920. Patient steadily improving.

September 9, 1920. Phthalein: First hour, 45 per cent; second hour, 20 per cent; total, 65 per cent.

September 10, 1920. Urine: Slightly cloudy; specific gravity 1008; neutral; albumen 0; sugar 0; casts 0; occasional epithelial cells; red blood cells 0; white blood cells 1–2 h.d.; few rods and cocci.

September 11, 1920. *Cystoscopy:* Kidney findings:

	Right	*Left*	*Transvesical*
Red blood cells		0	0
White blood cells		1–2 h.d.	6–10 h.d.
Casts		0	0
Epithelial cells		2–3 h.d.	1–2 h.d.
Organisms		None seen	Occas. cocci

Cultures: Staphylococcus aureus in both specimens.

Phthalein: Appearance time, 2½ minutes; first fifteen minutes, 15 per cent; second fifteen minutes, 4 per cent; total, 19 per cent.

Leakage, none.

Remarks: Right side catheterized within about 6 cm. from orifice, beyond which it does not pass. Pyelogram was taken.

September 15, 1920. Urine: Staphylococcus aureus in both left kidney and bladder.

September 16, 1920. *Discharged.* In good condition.

Diagnosis. Stone in left kidney.

April 14, 1922. Patient has been under observation and getting intermittent treatment for a chronic prostatitis. The urine has remained clear and he has had no lumbar pain. The cystic calcification of the right kidney is progressing but this dead kidney is causing no disturbance. Recent functional studies show normal total function.

Discussion. Case 2 emphasizes the necessity of early diagnosis and early treatment if one wishes to be successful in the preservation of renal tissue. Where there has already been complete renal destruction, surgical alterations that earlier would have been followed by repair are obviously useless. The difficulty lies in the recognition of the extent of the destruction. A very considerable reserve power may be so inhibited as to give all the evidence of complete destruction. A distinct indication is present in this patient, on account of stones being present in the opposite kidney, of strict conservation, and the attempt to bring about repair seems justified.

Case 3. U. C. H. 5289. Male, age forty-two. Admitted November 24, 1919.

Complaint. Pain over right kidney region.

Family history. Negative.

Past history. Age twenty-five, malaria. Mumps without complications. No typhoid. "Inflammation of bowels," 1897, in bed six weeks.

Systems: Central nervous system, negative; gastrointestinal, negative; cardiac respiratory, negative; genito-urinary, nycturia two or three times.

Venereal: Denies Neisser and lues. During past twelve to fifteen years lost 38 pounds in weight.

Present illness. Began age twenty-five with pain in right side under ribs, accompanied by nausea and vomiting. Since then patient has had recurrent attacks at irregular intervals—every week to as long as two to three months—lasting from one hour to twelve hours; relieved only by morphine. Has never been jaundiced; pains have never radiated to shoulder. Pain is not related to meals, exercise or otherwise; is relieved somewhat by lying on stomach with pressure applied. Sometimes pain leaves as suddenly as it came; at other times disappears gradually. At times before the attack, and even during the attack, he has frequency of urination; small amounts with burning and

some pain in head of penis. Has frequently noticed that after disappearance of pain, he has passed large amounts of urine with "pus"—so much pus that urine would hardly run. Constipation or diarrhea during attacks. No blood in stools.

Physical examination. Thin, underdeveloped, undernourished, middle-aged man, lying in bed; apparently in pain.

Skin, sclera, head, hair, ears, nose: Negative.

Eyes: Pupils contracted (after g.¼M.S.); equal round, react to light and darkness; external muscles O.K.

Mouth: Blood stains on lips, tongue and in mouth. Teeth bad shape, snags, caries, many out; pyorrhea. Tongue protrudes in midline with slight tremor; tonsils and pharynx negative.

Neck: No adenopathy.

Chest: Thin, symmetrical, front moves equally with diminished movement right base behind; no abnormal masses or pulsations; retracted supra clav. pressure.

Lungs: Dull to percussion right top front and back; diminished percussion note over remainder right side. Kroenig's area half gone left top. Bronchial breathing right top, less marked below clavicle; breath sounds faint and distant below second rib in front and below angle of scapula behind. Excursion diminished on right.

Heart: Negative to percussion; sounds moderate quality; no murmurs; A_2P_2. Rate 60.

Abdomen: Marked rigidity of muscles on right side; unable to palpate due to failure of coöperation of patient.

Back, genitalia, extremities and reflexes: Negative.

X-rays taken November 20 show stone in pelvic portion of right ureter. Plain plates of kidneys, ureter and bladder otherwise negative.

Urine: All three glasses turbid. Many pus cells. Acid. All +++. sugar 0.

Meatotomy performed.

November 21, 1919. Phthalein: First, 45 per cent; second, 20 per cent; total, 65 per cent.

No. 26 F. sound passed to bladder.

Sterile culture of bladder urine shows Staphylococcus albus. Gram stain. Gram + cocci.

November 25, 1919. Urine: Reaction acid; albumen +++; sugar 0; many red blood cells; few pus cells.

Cystoscopy. Residual urine: 20 cc.

Bladder capacity: 250 cc.
Kidney findings:

Right	*Left*	*Transvesical*
40–60 qhd.	R. B. C. 2–3 qhd.	5–10 qhd.
13–15 qhd.	W. B. C. 0	15–20 qhd.
0	Casts 0	0
1–2 qhd.	Epithel. 1 qhd.	Few
Motile rods	Organisms 0	Motile rods

Cultures: Right kidney, left kidney taken (November 28) Staphylococcus albus in both specimens.

Pyelography: 50 cc. pelvic capacity.

Taken right kidney. Pain reproduced. Same as present illness.

Remarks: Cystoscope enters with ease. Vesical neck edematous, otherwise negative. Vessels of trigone are dilated. Right ureteral orifice is edematous the opening being enlarged and twice size of left. The mucosa surrounding the orifice presents numerous white deposits which float away but still remain attached on introducing the irrigating fluid. The bladder walls show these same deposits. The posterior bladder walls show some coarse trabeculation that do not stretch out on dilating the bladder. Both ureters catheterized with ease. Bladder irrigated with boric through catheter until returned clear. Bladder capacity averages 435 cc. before patient complains of distension. Retention catheter inserted, no. 18.

X-ray report. Pyelogram of right kidney; hydronephrosis, hydroureter; stone in lower ureter (at about brim of pelvis) (fig. 30).

November 26, 1919. Since cystoscopy patient has been unable to void and has had to be relieved of from 500 to 400 cc. of bloody urine per catheter every seven hours. Severe pain from vesical distension.

November 27, 1919. Temperature 38.7°C. Still unable to void, requiring catheterization at about seven-hour intervals.

November 28, 1919. Still unable to void and becoming more difficult to catheterize. No. 24 soft formerly used. No. 18 Caude now introduced with difficulty. Two marked planes of resistance to passage of catheter: (*a*) bulbous urethra; (*b*) prostatic urethra.

Temperature, pulse and respiration have dropped to normal this morning.

Urine is acid, cloudy, small amount of old blood; some bacteria and pus cells.

November 30, 1919. Abdomen distended, bladder nearly to umbilicus; marked tenderness over right lower quadrant. Abdomen too spastic to feel organs. O.K. for anesthetic. Teeth very bad.

December 1, 1919. Temperature, pulse and respiration down to normal. Retention catheterized in place for three days. Irrigations b. i. d. No burning or sharp pains.

December 3, 1919. Teeth extracted.

Phthalein: First specimen, 35 per cent; second specimen, 15 per cent; total, 50 per cent.

Blood: Hemoglobin, 64 per cent, white blood cells, 18,400; red blood cells, normal. N, 77 per cent; SM, 14 per cent; F, 2 per cent; E, 4 per cent; B, 1 per cent; My, 1 per cent.

December 5, 1919. Retention catheter has been out for forty-eight hours. Patient voiding without difficulty. Slight hematuria.

December 6, 1919. *Operation.* General condition: Good except for moderate anemia.

Reason for operation: Right ureteral calculus.

Operation: Gas and oxygen anesthesia. The skin was prepared with alcohol, ether and biniodid. An incision about 6 cm. long was made just to the right of the midline and midway between the symphysis and the umbilicus. The incision was carried on through to the bladder which was identified and separated from the adjoining tissue by means of blunt dissection and the gloved finger. A search was then made for the right ureter and a large vessel which very closely resembled the ureter was found. This was followed superiorly and inferiorly until a branch was found coming from it. The vas deferens was then encountered and it in turn was followed in hope of finding the ureter. Just at the brim of the pelvis a very large ureter about 1.5 cm. in diameter was discovered. This was opened by a longitudinal incision about 1 cm. long and silk traction sutures inserted in the flaps. A ureteral catheter was then passed in turn into the bladder. The portion of the ureter superiorly was found to be obstructed about 6 cm. from the incision. Ureteral dilators were then inserted and the ureter dilated. Rongeur forceps were then used to remove a calculus which was about 1 x 0.5 x 0.5 cm. The incision in the ureter was then closed by means of no. 0 catgut sutures. The posterior sheath of the rectus and muscles were drawn together with chromic no. 2 as well as the subcutaneous tissue. Two tension sutures were inserted and the skin closed with buttonhole black silk sutures. A stab wound was made to the right of the incision for the insertion of a rubber tube drain and one gauze pack.

Condition of patient on leaving operating room: Good.

December 9, 1919. Small amount hemorrhagic drainage from rubber tube. Patient voiding through catheter.

December 12, 1919. Wound healing well.

Urine: Small pus cells, 1020; sugar 0; diac. 0; reaction alkaline; albumen slight trace; red blood cells +++; cast 0; white blood cells 0; amorphous material.

December 16, 1919. *Cystoscopy.* Kidney findings:

Right	*Left*	*Transvesical*
0	R. B. C.	0
Entire field full	W. B. C.	40 qhd.
0	Casts	0
4 qhd.	Epithel.	4 qhd.
Few rods	Organisms	Many rods
Solid pus		Debris

Cultures: Bladder and right kidney.

Remarks: Right ureter catherized with no. 7 and pelvis instilled with 6 cm. 1 per cent A_gNO_3 and allowed to drain.

Urine: Small pus cells 1020; sugar 0; albumen slight trace; reaction alkaline; pus ++++; cast 0; white blood cells 0; bacteria, occasional rod; epithelial cells +.

December 19, 1919. Phthalein: First hour, 35 per cent; second hour, 20 per cent; total, 55 per cent.

March 30, 1920. Reëntry.

March 30, 1920. *Cystoscopy.* Kidney findings:

	Right	*Left*	*Transvesical*
Red blood cells	2–3 qhd.	7–8 qhd.	2–3 qhd.
White blood cells	8–10 qhd. + Clumps	Rarely	40–50 qhd.
Casts	0	0	0
Epithelial cells	2–3 qhd.	3–5 qhd.	Occas.
Organisms	Rods +	None found	Rods +++

Remarks: $AGNO_3$ 1 per cent injected into each pelvis.

March 31, 1920. March 31: Discharged, with advice to return in two weeks.

April 19, 1920. Reëntry: Since discharge in December, 1919, patient has had two attacks, during which he had a violent chill and a high fever. Last one two or three weeks ago.

Heart: Negative.

Blood pressure: 106–70.

Phthalein: First hour, 35 per cent; second hour, 10 per cent; total, 45 per cent.

Urine: Cloudy, slightly yellow, acid; sugar 0; albumen 0; sediment 0; red blood cells 0; white blood cells 60–70 qhd.; epithelial cells +; casts, organisms, rods +++.

April 20, 1920. Right nephrectomy.

General condition: Good.

Reason for operation: Pyonephrosis.

Gas and oxygen anesthesia. The field of operation was prepared with alcohol, ether and biniodid. The usual incision for right nephrectomy was made parallel to and just below the margin of the tenth rib about 10 cm. long.

There was very little subcuticular fatty tissue. The muscles were not very heavy. The fascia and muscles were cut through down to and exposing the capsule of the kidney. Retraction with wide blade retractors brought the kidney well into view. By blunt dissection for the most part the kidney was freed of the few adhesions which were about it. It presented the picture of pyonephrosis. The ureter, however, was very small and seemed to come off almost down in the kidney. The pelvis was not markedly dilated. A ribbon tape was placed about the ureter, traction upon which brought the ureter into view. The renal vessels were identified and Ferguson clamps applied, after which the kidney was cut from its vessels at the hilus. The ureter was cut about 3 cm. from the pelvis. The ureter and kidney vessels were tied with no. 2 chromic catgut ligatures and clamps removed after the ties were placed. There was very little bleeding. The vessels were tied with no. 1 plain catgut. A small gauze strip was placed, as well as two rubber tubes for drainage. The wound was closed about these, no. 1 chromic continuous suture for the muscles and fascia, two silkworm gut retention sutures, no. 1 plain catgut for the subcuticular tissue and black silk in the skin.

Condition of patient on leaving operating room: Good.

Pathological report: Microscopic examination of hydronephrotic kidney shows extensive destruction of the cortex and medulla with irregular foci of lymphocytic infiltration and fibrosis. Numerous hyalin glomeruli and marked hyalin thickening of blood vessels occurs. In between the more or less focal degenerations there are areas of comparatively normal kidney tissue. Such areas show cloudy swelling of the epi-

FIG. 30. This ureterogram is similar to that obtained in case 1 and the ureteral stone is about the same in size and position. Removal of the stone in either did not lead to improvement in the function of the corresponding kidney; in case 1, because the stone had so long and completely blocked the ureter as to have destroyed the renal tissue above, and repair was not possible even though there was a demand for it, a stone being present in the opposite kidney; and in case 2, because injury, while not complete, was sufficient to have caused compensatory changes in the opposite kidney and a demand for the repair of this injured side was wanting after removal of the stone.

thelium. The pelvis is lined by the usual epithelium, beneath which in some areas there is fibrosis and edema and sparsely scattered inflam-

FIG. 31. Pyelogram of the left kidney showing relative small hydronephrosis as compared to figures 37 and 38, and yet this kidney whose obstruction undoubtedly was removed by ureterolithotomy showed less repair than the others subjected to technically difficult plastic operations. The reason is absence of demand for repair of this left kidney.

matory cells. In other areas there is marked inflammatory infiltration beneath the epithelium, principally lymphocytic, but scattered in this layer are fairly numerous giant cells of foreign body type and large

mononuclear phagocytic cells staining a peculiar purplish gray, the same color that the giant cells stain. This reaction is apparently associated with thorium injection.

Diagnosis. Chronic phylonephritis with hydronephrotic atrophy. Thorium reaction in pelvis.

April 21–30, 1920. General condition: Good.

May 3, 1920. Phthalein: First hour, 20 per cent; second hour, 30 per cent; total, 50 per cent.

May 4, 1920. Discharged.

Condition: Well.

April 1, 1922. Patient in a letter states that he has remained perfectly well.

Discussion. Case 3 is analogous to type 3 in experimental hydronephrosis. Competition between the capable and hypertrophic left kidney and the infected hydronephrotic one, was leading to the gradual and ultimate destruction of the latter. It illustrates the small likelihood of success in repair operations for unilateral conditions when the opposite kidney is compensatory and healthy.

Case 4. P. C. 764. Woman, age thirty-five. Referred by Dr. Max Rothschild and Dr. J. Wilson Shields.

Complaint. Intermittent fever and pyuria.

Family history. Irrelevant.

Past history. Patient has always enjoyed excellent health up to a short time following her last childbirth in May, 1915. There has been no history of focal infection such as abscessed teeth or tonsillitis. Following her childbirth, she had intermittent attacks of chills and fever which were attributed definitely to an infection in the broad ligament of the left side. At this time the urine was normal. A little later in May, examinations of the urine showed a bacilluria due to a peculiar type of colon bacillus with a few polynuclear cells and a few hyaline casts. Blood culture at this time was negative. Spleen was large and soft and there were marked hemorrhoids which were not infected. Her general poor condition continued; the hemorroids troublesome and she complained of pain in the neck. In August, 1917, urine still showed a slight trace of albumin with a number of white cells and bacteria. Patient was treated by rest in bed, regulation of diet, control of the bowels in a attempt to relieve urinary infection. The latter part of

1917, hemorrhoids were removed by operation. Complete gastro-intestinal studies were negative with respect to gall bladder or other intestinal focus.

The phthalein output in March, 1918, was 75 per cent in two hours. At this time infection was much more pronounced on the right side than on the left as shown microscopically, but the phthalein outputs were approximately equal. In June, the phthalein output was 76 per cent and careful bacteriological study of the urine showed a typical anaerogenic paracolon which will grow only upon blood agar plates. Stool specimen examined in June showed normal flora. More complete urologic study in June showed that there was a bilateral hydronephrosis, dilated ureter and movable kidney on the right side, the hydronephrosis on the left being apparently due to a valve-like obstruction at the uretero-pelvic juncture. Infrequent attacks of fever with a dull pain in the right or left side and severe headaches lasting for several days continued to recur.

In September, 1918, uretero-pyelography confirmed the previous finding, showing a rather dilated and tortuous upper right ureter with a hydronephrosis which showed a pelvic capacity of 40 cc. and marked blunting of the minor calyces. Right kidney is quite movable. Left kidney is definitely square-shaped and ureter is not dilated on this side (fig. 32). Left pelvis has a capacity of approximately 45 cc. The phthalein output showed marked variation according to whether the tip of the ureteral catheter had entered the respective pelvis or not, as for example, on March 11, 1919, phthalein with the right catheter not in the right pelvis, but the left one well up in the left pelvis appeared on the left side in five minutes, right side eight minutes; the first fifteen minute output, right side 2 per cent, left side 15 per cent. Whereas, on March 14, with the position of the catheters reversed, the phthalein output on the right was 10 per cent and on the left 5 per cent. Total phthalein on March 13, 1919, was 30 per cent first hour, second hour not taken.

On April 10, total output was 27 per cent first hour, and 11 per cent second hour. Repeated phthalein estimations have shown a very definite and progressive diminution in renal function during the last two or three years.

This résumé of her history lead up to the necessity of consideration of more radical measures, in order to clear up the bilateral infection and the very definite progressive diminution in renal function on both sides. A complete outline of the history with the pyelograms of the right and

left side were submitted in consultation to a New York and a Baltimore urologist, as to the advisability of surgical interference and as to whether this should be conservative or radical. The former advised left nephrectomy and we quote this brief abstract from his letter:

. . . . firmly of the opinion that as the parenchyma of the left kidney was probably infected, from the length of time that the infection

FIG. 32. Pyelogram of the left kidney of case 4 before plastic repair of the uretero-pelvic juncture and nephropexy. A box-shaped pelvis of a capacity of of 45 cc. Infection has been present for years.

had existed and the dilatation of the pelvis of the left kidney, that any plastic operation would not be successful, and thought the wisest thing to do would be to remove the left kidney. That he found in a large proportion of cases, operated on by himself and others for plastic operations, almost invariably resulted in a subsequent nephrectomy and he feared a plastic operation in her case would so result."

The latter urologist advised as follows:

"I have gone over Dr. Hinman's findings in the case of ——— and fully agree with the suggestions for treatment he has outlined. The obstruction which has resulted in the double hydronephrosis is unquestionably at the uretero-pelvic junction and as the hydronephrosis is apparently progressive, it should be corrected. I feel, however, that such preliminary measures as pelvic lavage, etc., should be tried out for the purpose of clearing up the left sided infection if possible. These cases are extremely interesting and in our experience are practically all of inflammatary origin. I feel sure that a plastic at the junction of pelvis and ureter should completely relieve the obstruction."

Continuation of repeated lavage failed to give any permanent relief of the infection and in view of the progressive diminution of the phthalein on both sides, operation was decided by all to be advisable.

April 26, 1919. *Plastic operation on pelvis*—Nephropexy. Gas and oxygen by Dr. Botsford. Iodine preparation; twelfth rib incision; kidney exposed and delivered. Kidney was lobulated and showed considerable hydronephrosis. Pelvis was loose and relaxed and the superior part could be seen to bag considerably below the ureteropelvic juncture, which was narrowed and constricted. The pelvis was dissected free and the ureters stripped free for a distance of 10 or 12 cm. below. Catgut stay sutures placed in a line directly above the ureteropelvic juncture and the pelvis opened by a slit in it for about 5 mm. Through this a catheter could be passed into the ureter and there was no evidence of definite stricture, the obstruction apparently being directly due to the valve-like position of the pelvis with reference to its ureter. With stay sutures the ureter and pelvis above were drawn out in a straight direction and an incision made of about 1.5 cm. in length, taking in the upper part of the ureter, the lower part of the related pelvis.

The center of this incision was brought together and the whole sutured with 00 catgut as for pyloroplasty, thus widening the ureteropelvic juncture considerably. A no. 10 ureteral catheter was cut obliquely with a window about 4 cm. about its end and passed through the pelvic opening down the ureter so that the window lay at the level of the pelvis. The opening about the catheter was then sewed tightly and a piece of fat tissue approximated over it, so as to act as a valve for closure after the catheter was removed. Kidney was then fixed by Brodell stitches with Pagenstetcher on French needles, the upper suture being placed above the twelfth rib; one suture from the mid-part

of the kidney to the lumbar muscles and one from the lower pole into the lumbar muscle. A rubber tube drain was placed posteriorly before fixation, and passed alongside the catheter in the ureter and pelvis and exit with it at posterior end of the wound. Muscles closed with continuous no. 2 chromic and double layer; skin closed with continuous silk interlocked.

April 27, 1919. For the last thirty hours the catheter in the ureter has been injected with 5 per cent argyrol, 5 cc. being injected each time every two hours. There has been considerable urinary drainage through the catheter. Urine has been darkly colored with the argyrol. Patient has been unable to void and has had to be catheterized. Catheter was removed without difficulty, drainage tube being left in place.

April 28, 1919. Following removal of catheter there has been practically no urinary drainage. Temperature has remained perfectly normal continuously. Considerable sera from the drainage tube. No hemorrhage.

April 29, 1919. Condition of the wound as on previous note. Less drainage than the day before. Patient still has to be catheterized. Temperature normal.

April 30, 1919. Patient has been extremely nervous and irritable. Condition otherwise satisfactory. Last night at 2 o'clock temperature rose to 99 and this morning at eight was $99\frac{4}{5}$. Wound appears as before. Still less sera than formerly and apparently there has been no urinary drainage since the removal of the ureteral catheter. About 8 cc. of 0.25 per cent Dakin's solution injected into the drainage tube which was then withdrawn for a distance of 5 cm. and cut-off.

May 2, 1919. Very little drainage from tube, which was today completely withdrawn.

May 3, 1919. Stitches removed. Wound looks fairly healthy, some redness at lower end; very little discharge; no urinary leakage.

May 6, 1919. This morning at 2 o'clock temperature again arose and reached 102 during the night. Patient seen late in the afternoon when temperature was still over 100. Urine still cloudy and some soreness in right kidney region. No mass or particular soreness in region of left kidney or in the left hypochondrium. On account of the purulent condition of the urine and temperature, it was thought advisable to immediately catheterize ureters which was done in patient's room by simply moving her to edge of bed. Both ureters easily catheterized. Apparently no retention in left pelvis, but considerable in the right.

Specimens collected and submitted to Dr. K. F. Meyer. Both kidneys lavaged with 2 to 3 cc. of 1 per cent silver nitrate. Specimens, examined by Dr. Meyer, show microscopically: right, few pus cells, many red blood cells and numerous paracolon-like organisms—some in long chains and others in coccoid form. Left urine, microscopically, few pus cells, few red blood cells, abundant organisms, both colon-like and in clusters like staphylococci. Cultures made from both sides.

May 24, 1919. Phthalein: First hour, 27.5 per cent; second hour, 30 per cent; two hours total, 57.5 per cent.

May 26, 1919. Cultural report on urine by Dr. K. Meyer: Pure coli.

June 20, 1919. The temperature rise of May 6 persisted for a period of ten to twelve days, gradually falling by lysis. During this time there was some swelling and tenderness of the right kidney and the urine continued to show organisms and pus, although there at no time were any bladder symptoms. Temperature came to normal and remained so for a period of about ten days and it was thought that patient was on the final road to recovery. On May 28, I left for Atlantic City, and two days later there was a second temperature rise, lasting for three or four days, during which time, the patient showed considerable prostration in the afternoon and also complained of some soreness in the right kidney region. This period of temperature subsided within three or four days to normal temperature and general improvement and a third grade pyrexia occurred lasting several days. Temperature came to normal again on June 14 and after two or three days of normal temperature and general improvement there was a rise again on the 18, to 102.

June 18, 1919. Phthalein: First hour, 30 per cent; second hour, 15 per cent; total, 45 per cent.

Leukocyte count 8600; hemoglobin 65 per cent; red blood cells 3600; 0 blood pressure, on June 20, 110–60.

After consultation with Major Shiels and Dr. Moffitt, who upon careful examination failed to find any evidence of a cause for temperature in the heart, lungs, or any of the viscera, the advisability of ureteral catheterization in order to determine the main source of renal infection, as well as to treat the condition locally was admitted.

June 20, 1919. *Cystoscopic examination.* Bladder negative. Ureteral orifices both somewhat dilated, but similar in appearance as on previous examination. Both ureters easily catheterized, catheters being injected with a steady stream of sterile water for passage into the ureters so as to prevent contamination. No. 6 catheters easily passed to level

of renal pelves on each side. There was a continuous steady flow of urine from the left kidney for a short period, about 3 cc. drainage. At first there was no continuous flow from the right but after injection and slight withdrawal of the catheter a steady stream of clear, very pale fluid, which was slightly cloudy and shredded occurred. The left pelvis was injected with 2 cc. 0.5 per cent silver nitrate and the right 5 cc. Catheters were allowed to remain for another ten minutes to allow drainage of this injected solution.

Patient complained of no particular pain or discomfort at the time of the examination. Specimens were taken immediately to Hooper Foundation and examined in conjunction with Dr. K. F. Meyer. After centrifugalization microscopically, right urine showed several red blood cells; few pelvic cells; numerous non-motile rods and clusters of streptococci. Left side, several red blood cells, few pelvic cells, 1 or 2 pus cells and 2 or 3 non-motile rods. Cultures made from each side preparatory to the making of a vaccine.

June 27, 1919. Urines:

Right		*Left*	
Pus	+++	Pus	+
R. B. C.	+	R. B. C.	+++
Casts	0	Casts	0
Org.	++	Org.	
Rods	−	Occas. rod	

Eleven cc. of one per cent Mercuro-chrome. Catheter plugged and left in three minutes.

Eight cc. Mercuro-chrome "220." Catheter plugged and left in two minutes.

June 30, 1919. Phthalein: First hour amount 200 cc., 35 per cent; second hour amount 200 cc., 22 per cent; total, 57 per cent.

Cystoscopic study. Bladder negative on inspection. Both ureteral orifices negative. Right side catheterized with Garceau catheter which was passed high up into the ureter. There was apparently no great retention in the kidney pelvis on this side. Urine came in periodic spurts, slightly cloudy and showed microscopically a number of pus cells and numerous rod-shaped organisms. Submitted to K. Meyer for bacteriologic study. Phthalein injected intravenously appeared through this catheter in four minutes and in fifteen minutes 12.5 per cent was excreted, which shows definite improvement over previous study.

There has been a gradual though slow improvement. The phthaleins have shown definite improvement, all of which has been due to the increase of function in the left kidney. There is apparently a gradual diminishing functioning of the right kidney and the right kidney shows practically all of the urinary infection, only an occasional positive culture being obtained from the urine of the left kidney. On January 19, 1920, catheters were passed into both kidney pelves. There were a few pus cells in the urine from each kidney and many rods in both. Phthalein appeared on both sides in three minutes and the total output in the next fifteen minutes for the right was 15 per cent and for the left 25 per cent. The kidneys were both acting very rapidly and the flow from the left catheter upon withdrawing it into the ureter, was not in any way interrupted or diminished which would seem to demonstrate that the obstruction on the right side is largely at the uretero-pelvic juncture, just as it had been found in the case of the left kidney. On March 3, 1920, the total phthalein output was 50 per cent the first hour and 20 per cent the second hour.

The patient then spent some time in France and during her stay there was under the care of Dr. Heitz-Boyer who treated her infrequently with ureteral catheterization and during the last several months obtained continuously negative cultures from the left kidney, but positive colon bacilli were continuously found in the right.

Pyelograms made by Dr. Heitz-Boyer showed that the obstruction on the left side has been relieved and that apparently the dilatation of the right pelvis is somewhat reduced by repeated catheterization, although this kidney is still quite movable. Following is the cystoscopic report of January 25, and January 26, 1921 made, by Dr. Heitz-Boyer:

Dosage par le methode gazometrique 0.25 0/00

Rein Droit Tube 1, 4.90 0/00
Rein Droit Tube 2, 5.12 0/00
Rein Droit Tube 3, 2.81 0/00

Rein Gauche Tube 1, 16.65 0/00
Rein Gauche Tube 2, 24.08 0/00
Rein Gauche Tube 3, 16.14 0/00

Urine Totale Tube 1, 12.29 0/00
Urine Totale Tube 2, 13.32 0/00

January 26, 1921.

Examen Cyto Bacteriologique.
De L'Urine Vesicale et des reux reins.

Dans les urines remises le lundi 24 Janvier, 1921, nous avons constate:

Urine Totale—Tube 1.

Grandes cellules epitheliales pavimenteuses. Leucocytes pas tres nombreux Pas d'hematies—Sur frottis, tres nombreux bacilles gram negatifs.

Urine Totale—Tube 2.

Grandes cellules epitheliales pavimenteuses. Leucocytes un peu moins nombreux Pas d'hematies. Sur frottis, tres nombreux bacilles gram negatifs.

Rein Droit—Tube 1.

Cellules uretero pyeliques nombreuses—uelques hematics—Pas de leucocytes—Sur frottis, bacilles gram negatifs pas tres nombreux ayant l'aspect morphologique de Bacillus coli. Uelques elements du petit diplocoque gram positif signales dans les examens precedents.

En route to American, patient was seized with an acute attack of fever in London, where she consulted Dr. Thomson Walker, who, however, did not cystoscope her and make any urologic study. His opinion, however, at that time was as follows:

"In view of the fact that patient is a semi-invalid, unable to take part in ordinary social life, an attempt to get rid of the right pyelitis by operation is justified. Lavage of the renal pelvis has had a prolonged trial and has failed. I recommend right nephrotomy and drainage of the right renal pelvis with continuous irrigation. If the kidney is found unduly movable, it should be fixed. The appendix should be examined through the lumbar wound and if diseased removed."

Patient had no attack after leaving London and was last seen by me on March 15, 1922, when the following note was made.

It would seem definitely proven by the course during the last two years, that the infection in the right kidney will not be eradicated without more radical measures than simple ureteral catheterization and lavage. The appearance of a coccus, as a secondary invader of this kidney renders the necessity of a consideration of a more radical method of treatment pertinent, although regular ureteral catheterization will keep this kidney in a much healthier condition than if neglected. In view of the compensatory hypertrophy of the left

kidney and the freedom of infection now for several years, its ability to carry efficiently the total renal work would seem certain, and, with this fact in mind, the quickest cure of the right-sided infection, and probably the safest cure, would be by nephrectomy. This would seem the wisest course also in view of the uncertainty of conservative surgery upon the right kidney at this time, as it is probable that simple kidney fixation would now be insufficient to completely clear up the infection in the right kidney and that nephrotomy with drainage and lavage treatments, in order to clear up this infection (at the time of the nephropexy), carries what would seem to be an unnecessary added risk. The choice of treatment, therefore, lies between a continuation of periodic ureteral catheterization and nephrectomy.

Instrument inserted without particular difficulty and inspection of bladder shows a rather reddened mucosa, the inflammatory reaction being particularly pronounced over the posterior wall. There is no ulceration or oedematous polyp formation, but the bladder wall gives the appearance rather of a profuse granular cystitis. The bladder capacity with cystoscope in place was 380 cc. no. 6 Albarran catheter inserted into each kidney pelvis without meeting obstruction and without difficulty. The relative findings of the right and left kidney were as follows:

Kidney findings	*Right*	*Left*	*Transvesical*
Character of flow.....	Continuous	Intermittent	
Macroscopic.....	Slightly cloudy	Clear	
Microscopic.....	Very pale	Highly pigmented	
Red blood cells.....	2–4 every h.d.	2030 every h.d.	0
White blood cells.....	4050 every h.d.	1–2 every h.d.	6–8 every h.d.
Epithelial cells.....	4–6 every h.d.	0	2–4 every h.d.
Casts.....	0	0	0
Organisms.....	Cocci, rods	0	Cocci, rods
Stained smear.....	Made	Made	

Cultures. Bladder, right kidney show B. coli and left kidney negative.

Phthalein:

Appearance time: Right, 4 minutes; left, 4 minutes.

First fifteen minutes: Right, 12 per cent; left, 27 per cent.

Second fifteen minutes: Right, not done; left, not done.

Leakage: None in bladder specimen at end of fifteen minutes.

Pain: None.

Remarks: T-Stained smear of right urine shows a few rods but very many cocci. Culture of bladder urine obtained by Cather March 11, showed B. coli.

Impression. The relative cystoscopic study indicates that the right kidney is badly infected and the left kidney is free of infection. The right kidney function is definitely reduced or inhibited, whereas, the left kidney is relatively hyperactive. The finding of a large amount of pus from the right kidney, which on stained smears shows the presence of both cocci and bacilli, renders the condition at this time more serious, than when the infection was a pure colon bacillus infection. The seriousness is more with respect as to the proper course of future treatment, than to any immediate necessity of radical treatment.

Case 5. P. C. 961. Woman, age forty-two, married. December 27, 1918. Referred by Dr. E. C. Fleischner.

Complaint. "Chills and fever."

Past history. Patient has borne five children and ever since the last child she has not felt well. For the last eight or nine years, has had considerable sinus trouble both in the ethmoid and frontal sinus. Saturday, without any apparent cause, she began to have burning and frequency of urination and a temperature. Seen by Dr. Fleischner who found on examining the urine that it contained pus and motile bacilli and considered that the patient had a colon bacillus pyelitis. Since then temperature has ranged between 100 and 103 and she has had frequent chills with profuse sweating, with a loss of appetite and infrequent pains low in the back, but no definite lumbar pain or kidney pain. Patient seen December 26, temperature 101, pulse 100, no lumbar or kidney tenderness; right kidney palpable. Urine is cloudy, shows numerous pus cells, hyaline and granular casts, occasional red blood cells, many epithelial cells.

Patient refused to go to the hospital for treatment; a trained nurse put on the case; given bicarbonate of soda for twenty-four hours. After the acute symptoms subsided this was changed to uretropine and acid sodium phosphate.

December 31, 1918. 10.18, cloudy, pus +++, stain pus cells, bacilli.

January 10, 1919. Deep amber, cloudy, 1022. White blood cells +++. Granular casts, rod shaped organisms.

January 20, 1919. Patient began to run a temperature; chilly sensations, pain in the right back. Unable to get nurse for her and entered Adler's Sanitarium today.

Cystoscopic examination. Urethral catheterization was done. Both kidneys were lavaged with 1 per cent silver nitrate.

Urine: Pus +++; no bacilli, casts, red blood cells.

January 22, 1919. Seen by Dr. Jellinek in consultation. Blood count: whites, 5100; reds 4,352,000. Hemoglobin 87 per cent; urine specimen clear. Mic. pus + much less than before.

January 23, 1919. Urine sample: bladder, right and left ureter. Pus cells in each sample examined.

January 25, 1919. Sterile specimen: Few pus cells only. No bacilli seen.

January 27, 1919. Left, no organisms, occasional pus cells, bladder negative. Right, pus cells, blood cells, few rod organisms.

January 29, 1919. Phthalein test: First hour, 22; second hour, 25; total, 47. (Note: The second "hour" test was only for fifty minutes.)

January 31, 1919. Urine sample: Very few pus cells; 0 blood cells, bacilli ++.

February 1, 1919. Phthalein: 10–35 – 7.

February 3, 1919. *Cystoscopic examination.* Both ureters catheterized. Phthalein not done.

Pyelogram: Right kidney shows hydronephrosis with marked kink of the ureter just below the pelvis. The ureter itself is markedly dilated and tortuous, and the dilatation is pronounced below the area of this kink. The plate is not low enough to show lower portion of ureter (fig. 33).

February 3, 1919. *Cystoscopic examination.* Urine from left side negative. Right side few pus cells, occasional rod-shaped organisms. Pyelogram made of the left kidney, shows kidney in normal position with a perfectly normal appearing pelvis, and major and minor calyces. Ureter not dilated, perfectly straight, apparently draining well. Uretrogram made of the right ureter shows stricture in region of iliac crest. The presence of infection, marked ureteral dilatation below the ureteral kink, and a pronounced hydronephrosis above, all indicate the improbability of kidney fixation giving permanent relief. In view of this nephrectomy would seem to be indicated.

February 10, 1919. Phthalein: Left: three minutes; 32 cc., 15 per cent, first fifteen minutes; 30 cc., 8 per cent, second ten minutes.

Right: four minutes; 54 cc., 20 per cent, first fifteen minutes; 34 cc., 7 per cent, second ten minutes.

February 11, 1919. Urine: Microscopically, no organisms.

February 12, 1919. Urine: Bladder: clear, many epithelial cells; no pus; rare bacillus. Right: Negative. Left: Negative.

FIG. 33. Pyelogram of right kidney of case 5. Definite obstruction at ureteropelvic juncture. Relieved by plastic surgery and kidney fixation. Chronic invalidism and renal infection with recurrent exacerbations for many years. Complete cure.

February 17, 1919. Phthalein: Right: 17.5 per cent, thirty minutes. Left: appeared three minutes; 27 per cent, thirty minutes. Transvesically no output.

February 28, 1919. *Cystoscopic study.* Bladder negative. Bladder urine shows only occasional pus cell. No blood, rare bacillus. Right ureter catheterized with large 7F without difficulty, meeting no obstruction apparently at the site of previous stricture. Passed easily to the kidney pelvis. Only slight retention. Pelvic capacity as measured with sterile water 45 cc. Phthalein given intravenously appeared

through the right catheter in two and one-half minutes. First fifteen minute output 17 per cent. Bladder catheterized at the end of this fifteen-minute period, 22.5 per cent phthalein present.

March 5, 1919. *Nephropexy.* Dilatation right ureter retrograde. Gas, oxygen and ether. Patient placed on kidney pad. Small curved twelfth rib incision, twelfth rib being short and the body form long. Liver was felt low through the incision. Kidney was found low at the lower end of the incision. Kidney was freed of the perirenal fat and by traction upon this delivered into the lumbar wound. There were marked fibrous adhesions all about the kidney which were freed by blunt dissection and scissors. Ureter could be seen at the lower portion and was quite tortuous in its course, the tortuosity being maintained by connective tissue bands surrounding it. These were freed, it being necessary to divide and ligate a small aberrant vessel coursing along the ureter, and which apparently assisted in keeping the ureter kinked.

The kidney was well freed at both its upper and lower pole and left attached only by its pedicle. Ureter was stripped for a distance of 10 cm. from its pelvis, was opened by longitudinal incision and a Bransford-Lewis ureteral dilator passed down the ureter to the level of the bladder. Upon withdrawing and gradually opening this, the point of stricture at the pelvic level could be readily felt and this was gradually dilated. Lewis dilator withdrawn and linear incision in ureter closed with 00 catgut. Continuous suture, a piece of fat being tied over this suture to reinforce it. Puncture drain placed about 2 inches below lower end of lumbar incision through which small rubber tube was passed to area of ureteral opening for drainage in case there should be leakage from this ureteral incision. Twelfth rib freed from subcutaneous tissues. Three Broedell sutures passed for kidney fixation with medium sized Pagenstecher. Kidney fastened up under twelfth rib and to sacrospinalis muscle, being held firmly and satisfactorily in this position. Could not be fastened very high on account of the low position of the muscles closed with two-layer continuous chromic gut no. 2; subcutaneous tissues with interrupted catgut, and skin with locked horsehair.

March 24, 1919. Right: Pus, none; organisms, none. Left: Pus, none; organisms, none.

March 27, 1919. Bacteriological report by Dr. K. Meyer. Kidney urines, negative on both direct and enriched cultures. Bladder shows B. coli.

April 25, 1919. Urine clear, negative microscopically.

March 30, 1919. Patient has been heard from several times since leaving San Francisco for her home in Canada and has remained well with no urinary complaint of any kind until one month ago. At this time she was rather busy and working hard because of illness in her family and as a result complained for a time of pain in the right kidney area which was not at all severe and pain in her bladder. There was associated with it, no frequency, and at this time she had a bad infection in one or both antri. A culture of a catheterized specimen made March 30, 1921, by Dr. G. J. Thomas of Minneapolis was negative and microscopic study of specimen was negative for pus.

Discussion. Cases 4 and 5 illustrate the success of repair operations but emphasize the grave danger of delay in bilateral disease in the performance of the repair procedure on the opposite kidney after successful repair on one side. The surgical problem after the delay although it is justified has led to the serious consideration of radical right nephrectomy in cure of rather than simple nephropexy, as originally indicated. A cure seems unlikely unless one or the other of these measures is adopted.

Case 6. Age twenty-six. Admitted January 15, 1920.

Complaint. Pain in right side.

Family history. Father dead, age forty-nine, typhoid. Mother, living and well; no brothers; three sisters living and well, two died in infancy. Never pregnant; married four years. Wants children. No history of tuberculosis, cancer; no kidney trouble.

Past history. Diseases: Measles, mumps, chicken-pox, whooping cough, bronchitis, tonsillitis. None since fifteen years ago. No rheumatism or "growing pains" in childhood.

Operation: On turbinate.

Accidents: Clavicle broken seven years ago.

Habits: Coffee 0; tea 2; no drugs or alcohol.

Past illness. Menstrual began age thirteen. Regular 28/5. Pain in back and side first days, relieved by flow; occasional headaches with periods.

Patient has always been in good health except as a child she had frequent urination. Eight years ago she fell. This was followed by a pain in right side. Was diagnosed appendicitis. This soon left. In September, 1918, while working hard, noticed it again. Free again. In April, 1919, took a two months' auto trip; pain recurred. Six years ago after fall she felt a lump in her right side. Is always a dull, aching,

more or less constant pain, sometimes radiating to groin but nowhere else. Is never a sharp pain. For the last six years she has had frequent burning, painful urination. Has also noticed the urine to be a very strong, foul odor. When her bladder is full the pain is worse. Since her trip in April, 1919, she has lost 9 pounds but has no other symptoms. Slightly incontinence on exertion for the last four years. Slightly increased frequency during day. Nocturia 1. No sudden gushes of urine. No edema. Headaches in top of head, usually caused by drinking coffee.

Cardiac respiratory: "Hay fever." Is dyspneic on exertion. Appetite poor since April, 1919. Bowels regular.

Physical examination: Average developed, average sized woman.

Scalp: Negative.

Skin: Negative.

Sclera and mucous membrane: Negative.

Eyes: Negative; pupils, eq. circ., reg., react to light and darkness.

Ears: Negative.

Nose: Negative.

Teeth, gums, tongue, throat, tonsils, neck, thyroid: Negative.

Glands: Occasionally one palpable.

Chest: Average development.

Breasts: Small, very little glandular tissue.

Lungs: Movement normal, resonant throughout. Fremitus negative. Breath sounds normal. No râles.

Heart: Apex in fifth specimen. Normal outline. Sounds regular, fair quality, rather rough and impure. No murmurs. Pulse: eq. reg., normal volume.

Abdomen: Flat, tympanitic, soft. Tenderness over right side. Both kidneys palpable. The right comes way below umbilicus, is freely movable. Left not so easily felt.

Liver: Edge 2 cm. below right costal margin.

Extremities: Negative.

Reflexes:

	R.	*L.*
Patellar	+	+
Achilles	+	+
Babinski	−	−

X-ray: Both kidneys well outlined. No evidence of calculi. Pelvis of left kidney normal in size (fig. 39). Slight blurring of calyces.

Pyelogram: Right kidney, dilated pelvis. Kidney drops ½ vertebrae in standing position, with kink in ureter (fig. 34).

Phthalein: First hour, 35 per cent; second hour, 15 per cent; total, 50 per cent.

FIG. 34. Pyelogram of the left kidney in case 6, which indicates a kidney not badly damaged yet function was gone and infection pronounced. The actual damage present is shown in figure 35.

January 19, 1920. Patient has been vomiting since her cystoscopy but is feeling very much better today. No vomiting since noon.

January 26, 1920. Patient doing fine. No complaints. Incision clean. Dressing changed.

January 29, 1920. Sutures removed. Incision healing per primum.
February 6, 1920. Patient discharged.

Ureteral catheterization record

January 15, 1920

	RIGHT	LEFT	TRANSVESICAL
Kidney findings:			
Red blood cells	Abundant	0	0
White blood cells	Occ.	Many	4–5 per h.d.
Casts	0	0	0
Epithelial cells	Few	Many	Many
Organisms			
Phthalein:			
Appearance time	3	?	
First fifteen minutes	40	2½	
Second fifteen minutes	15	5	
Total	55	7½	
Leakage	Less than 1		

Ureteral catheterization record

January 17, 1920.
Residual urine: See previous chart.
Bladder capacity: See previous chart.
Bladder findings (described on chart).

	RIGHT	LEFT	TRANSVESICAL
Kidney findings:			
Cultures: Not taken			
Phthalein:			
Appearance time	5 minutes	9 minutes	
First fifteen minutes	35 per cent	Trace	
Second fifteen minutes	15 per cent	2 per cent	
Total	50 per cent	2 per cent	
Leakage			

Pyelography: Right pyelogram taken (1) Prone; (2) Standing.
Pelvic capacity: Right, 20 cc. thorium; left, on pelvis.
Pain: Little.

Remarks: No. 6 catheter passed to both renal pelves with ease.

Operation. Left nephrectomy (January 22).

General condition: Good.

Reason for operation: Exploratory of left kidney.

Operation: Gas and oxygen anesthesia. The field of operation was prepared with alcohol, ether and biniodid. An incision about 10 cm. long was made about 2 cm. below the tenth rib and parallel to it, extending from the costo-vertebral angle toward the umbilicus. The subcuticular tissues and muscles (latissimus dorsi and lateral edge of the erector spinae) were divided through the deep fascia, exposing the perirenal fatty tissue. This was dissected by blunt dissection down to and exposing the kidney on this side. Palpation showed this kidney to be very small and soft. It was uncovered of its perirenal fat and exposed. It was about 5 cm. long and contained a markedly dilated pelvis. The condition was apparently one of slow atrophy from long continued hydronephrosis. Because of the extremely low function on this side and of the useless condition of the organ, a nephrectomy was thought to be the operation of choice. The kidney was dissected free from numerous vascular adhesions, these being clamped and tied in succession. The kidney vessels were cleared and three large Ferguson hemostats were applied near the hilus. The ureter was clamped with a Mayo hemostat about 2 cm. below its pelvis after being first brought up out of the wound by a string tape. The ureter was cut off at its point of clamping, its end cauterized with carbolic and alcohol, the ureter released and retracted along its course. The kidney vessels were next cut at the hilus and the kidney delivered. Suture of the renal vessels was accomplished with no. 2 chromic catgut sutures. The clamps were released one at a time. There was no subsequent bleeding. No drainage was used. The deep fascia was closed with running no. 2 chromic catgut, muscles with running locked no. 2 chromic and the subcuticular tissues with no. 1 plain catgut. Two silkworm gut retention sutures were placed and black silk, locked, was used for the skin.

Condition of patient on leaving operating room: Good.

Specimen consists of left kidney and proximal portion of ureter preserved in 10 per cent formalin, measuring 5.5 cm. in length, 2 cm. in greatest thickness, and 2.6 cm. greatest distance across.

The capsule does not appear thickened. Hyperemic areas show through on its surface corresponding to scar-like depressions where it is adherent. Except for these few adhesions the capsule strips readily.

The kidney appears shrunken, the cortex presents deep irregular depressions from what are apparently old scars, and hyperemic areas varying from pin point to 1 cm. in diameter show through on the cortex.

On section almost the entire parenchyma is seen to be obliterated (fig. 35). The cortex is represented by a thin shell less than 1 mm. thick except one small area about 1 cm. long, where the cortex is about 0.5 cm. thick. This, however, is irregularly hyperemic and the normal structural markings are not clear.

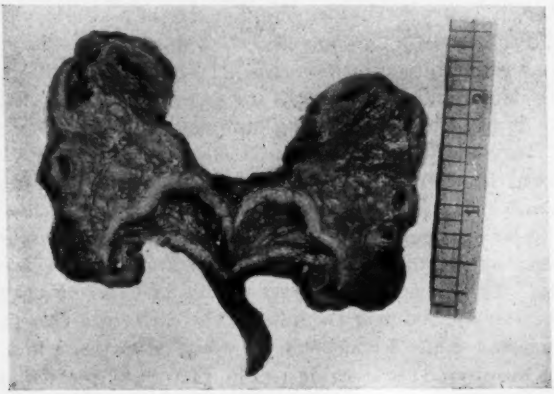


FIG. 35. Left kidney of case 6, after removal pyelogram in figure 34. One small secretory nodule at the lower pole remains. The specimen closely resembles that of dog 17-13, figure 10. There is almost complete atrophy, which hardly can be considered disuse atrophy, as the opposite kidney is movable and hydronephrotic and unable to compensate for the loss of the left kidney.

The pelvis is enlarged, and large dilated calyces have apparently encroached on the kidney substance, running clear out to the cortex, and destroying the whole parenchyma by pressure atrophy. The wall of the pelvis is greatly thickened and thrown into folds, due probably to contracture of a fibrous nature following a primary dilatation. The lobulation on the surface of the kidney corresponds to the dilated calyces within. There is a large amount of fat about the pelvis and calyces.

The ureter appears smaller than normal, its lumen near its proximal end being less than 2 mm. in diameter and its wall slightly thickened and very stiff.

The specimen is unusual in showing almost complete destruction of the parenchyma.

Microscopic section (comprising sagittal section of the whole kidney) reveals an extreme picture of hydronephrotic atrophy. The capsule is very slightly thickened and adherent in a few places. The tubules are atrophied; they possess no lining epithelium and contain hyalin material. The individual tubules appear widely separated due to the extreme fibrosis and lymphocytic infiltration of the interstitial tissue. The blood vessels are thickened. Small foci of lymphocytic infiltration are seen here and there in the neighborhood of the pelvis.

The glomeruli are entirely obliterated except in one small area noted in the gross, where the cortex was about 0.5 cm. in thickness. Here there are a large number of glomeruli, none of which, however, appear normal. The tufts are swollen, some adherent to the capsule; others present hyalin changes and lymphocytes; in many the capsules present fibrous thickening. The tubules here show extreme parenchymatous degeneration. There is peritubular hemorrhages in several areas. The pelvis exhibits submucosa thickening, and exudate of chronic inflammatory type. There is a large amount of fat about the pelvis.

Diagnosis. Hydronephrotic atrophy, irregularly distributed with contraction. Chronic glomerulo nephritis. Evidence of old infection.

Clinical laboratory record

Blood

	WHITE BLOOD CELLS	NEUTROPHILES	EOSINOPHILES	BASOPHILES	LYMPHOCYTES	LARGE MONONUCLEARS AND TRANSIT
1/21/20	8,000	68	1	0	22	9

Urine

	AMOUNT	SPECIFIC GRAVITY 1000 AND	REACTION	ALBUMIN	SUGAR	
	cc.			*per cent*	*per cent*	
1/15/20	5	18	Ac.	0	0	Few pus cells; many epithelial cells; no red blood cells. Few bacteria
1/19/20	5	14	Ac.	0	0	Few pus cells. No red blood cells; many epithelial cells. Occasional bacteria
1/21/20	5	17	Ac.	0	0	Few pus cells; many epithelial cells

May 7, 1920. Rëentry. For right nephropexy.

Phthalein: First hour, 45 per cent; second hour, 20 per cent; total, 65 per cent.

May 8, 1920. Operation: Right nephropexy.

Operation. General condition: Good.

Reason for operation: Fixation of a ptosed right kidney with starting hydronephrosis.

Operation: Gas and oxygen anesthesia. The field of operation was prepared with alcohol, ether and biniodid. A skin incision of probably some 14 cm. was carried about 1 cm. below the costal margin, the center of the incision being slightly to the rear of the mid-axillary line. This incision was carried directly down through the subcutaneous tissue and muscles to the perirenal fat. Blunt dissection by means of Mayo hemostats produced yellow tinged fat diagnostic of position of the kidney. This was stripped back and the capsule bared. The kidney was then delivered into the wound also by blunt dissection and all adhesions freed. After the ureter was shown to be thoroughly free below, three retaining sutures of Pagenstecher were taken into the kidney substance. Small pads of the perirenal fat which had been removed previously were placed beneath any extra-renal portions of the Pagenstecher suture. These sutures were so placed that one was at the superior pole and slightly anterior to the lateral posterior line; the second was just posterior to the same line in the middle of the kidney, and the third was taken near the lower pole in about the same position as far as the lateral line of the kidney was concerned. All of these sutures were placed some 3 mm. deep. A long curved needle easily brought the superior sutures up under the rib margin and the kidney was held fast there by bringing both ends of the suture upwards and fixing it by a tie. The two lateral sutures were brought through the lumbar muscles, fixing the kidney well laterally by that method. All were tied and cut and the kidney found to be in fixation. Closure was effected by means of two locked chromic no. 2 muscular sutures, doubled no. 00 iodized running suture subcutaneously and plain running silk in the skin. Two deep kangaroo tendon retention sutures were placed and tied.

Condition of patient on leaving operating room: Good.

May 13, 1920. Silk sutures out. Wound in excellent condition.

May 20, 1920. Wound all healed.

May 23, 1920. No complaint of any character. Eating well and gaining weight.

June 2, 1920. *Discharged.* Condition good.

Discussion. Case 6 is an example of bilateral injury with final atrophy on one side and shows the great benefit from repair

FIG. 36. Pyelogram of right movable kidney of case 6 treated at a second operation (first, left nephrectomy) by uretero-pelvic plastic and fixation. Complete cure, no infection, total function, normal.

on the other in response to the definite demand for it. The interesting point for speculation is in regard to the relative duration

of the injury on the right and left sides. A healthy condition on the right would have hastened the atrophy on the left, and it is more than probable that the left hydronephrotic damage has come on after the right function had ceased from an earlier damage. Had they been concurrent the left might not have atrophied so extensively.

Case 7. Girl, age six. Admitted, July 26, 1918.

Complaint. "Thick and shreds in urine."

Family history. Father living and well; mother living and well; two sisters living and well; one brother living; one brother dead (twin and died at birth). No miscarriages. No history of tuberculosis, cancer or epilepsy in family.

Past history. Full term—normal delivery. Breast fed fourteen months.

Development: First tooth at six months; walked at nine months; talked at eighteen months.

Diseases: Chicken-pox and measles.

Accidents: None.

Operations: Tonsillectomy, adenectomy, hemorrhoid.

Past illness. Three years ago mother first noticed urine was cloudy. Before this the child had been in the habit of getting up frequently during night, but for last six months this has diminished, although there has been burning and pain on urination. There seems to be a great deal of thirst and child drinks a large amount of water.

Physical examination. Patient is a fairly well developed but undernourished child of six years.

Skin and mucous membrane seem pale. Heart is not remarkable.

Hair is rather thick.

Eyes, pupils equal and regular and react to light and accommodation.

Nose not remarkable.

Mouth: Tongue clean; teeth well kept. Tonsils out and pharynx clean.

Ears apparently negative. Posterior cervical lymph nodes are the size of peas and hard.

Chest: Rather poorly clothed. Infraclavicular fossae rather marked.

Lungs: Expansion good and equal on the two sides. Resonance good throughout. Tactile frenutus neg. Breath sounds of good quality. No râles heard.

Heart: Outline negative. Sounds of good quality. Rhythm good. No murmurs.

Abdomen: Slightly thin but soft. Edge of liver palpable below costal margin. Tip of spleen felt on deep palpation. No tenderness.

Extremities: Not remarkable.

Skin: There are a few papules and scabs over the flexor surface of the forearms, on one shoulder, on one cheek and on both legs. (The child says her sister has it too.)

Reflexes: Normal.

July 30, 1918. Wassermann taken, negative.

July 31, 1918. Blood pressure: systolic 90; diastolic 60.

August 6, 1918. Catheterized specimen of urine sent to laboratory for G. P. inoculation.

Cystoscopy. Showed large dilated ureteral orifice, with a diffuse granular cystitis. No definite ulcerations seen. No foreign bodies in bladder; no diverticulum. Neither ureteral orifice shows papules or edematous appearance of tuberculosis. Each catheterized. Specimen collected through catheters is same in character as bladder urine. Many pus cells in both; no organisms seen on stained smear. Functional study not done but patient taken to x-ray room and pyelograms (shown in figure 37) showed marked deformity of each pelvis. Major and minor calyces are blunted and dilated and there is considerable cystic formation. Pyelograms indicate a chronic pyelonephritis, with blunting and dilatation of the pelvis and calyces, which in view of the repeated urinary cultures, is probably due to tuberculosis. In view of the bilateral nature of the condition, nothing surgically can be done. Report of guinea pig inoculation never obtained.

April 14, 1920. Patient was returned to the hospital and mother states that she has been fairly well since her discharge two years ago until about three weeks ago, when she fell, striking the abdomen over the bladder. At the next urination she became faint and nauseated and had to be put to bed. After the first two days she was able to get up for a short time but since then, or for the last two weeks, has been continuously in bed. The frequency and pain at end of urination have been gradually increasing in severity, so that now she voids about every thirty minutes and complains of a severe pain in the bladder region and in the kidneys. The pain comes on each urination and lasts as a rule for about five minutes. She practically always has a bowel movement with each urination during the last two weeks and the mixture sometimes contains blood, which has been thought to come

from hemorrhoids. She has no headaches, no frequent coughs or colds. Was gaining in weight until present illness. No night sweats. Appetite good until four days ago, when it was necessary to take laxatives for constipation.

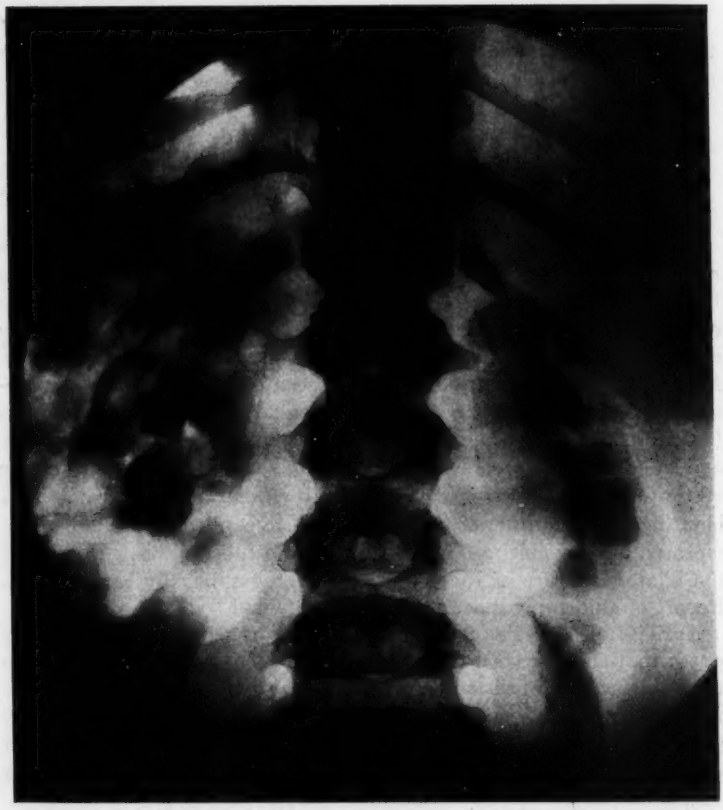


FIG. 37. Bilateral pyelogram showing enormous hydronephrotic sacs on both sides, with tortuous ureters as large as intestines. Marked renal insufficiency and urinary sepsis. Two stage repair operations with remarkable improvement of function and the renal infection (case 7).

Physical examination. Aside from the child being rather thin and pale, the physical examination is negative, as reported in previous history.

April 19, 1920. Phthalein test: First hour, 4 per cent; second hour, 10 per cent; total, 14 per cent.

Ureteral catheterization record

April 15, 1920

	RIGHT	LEFT	TRANSVESICAL
Kidney findings:			
Red blood cells	Not running	1–2 qhd.	2–4 qhd.
White blood cells		1–2 qhd.	Field solid
Casts		0	0
Epithelial cells		0	Occas.
Organisms		0	0
		Mostly mucus	

Cultures: Taken, bladder and left kidney. No bacteria. Cultures sterile. G. P. inoculation.

	RIGHT	LEFT	TRANSVESICAL
Phthalein:			
Appearance time	Not run-	8 minutes	
First fifteen minutes	ning	Slight trace	
Second fifteen minutes			
Total			
Leakage			0 per cent

Ureteral catheterization record

April 20, 1920

	RIGHT	LEFT	TRANSVESICAL
Kidney findings:			
Red blood cells		0	3–4 qhd.
White blood cells		2–4 qhd.	Clumps
Casts		0	0
Epithelial cells		0	Few
Organisms		0	Rods +

Cultures: Bladder, right kidney and left kidney. Bladder: Streptococcus viridans; left kidney, sterile.

	RIGHT	LEFT
Phthalein:		
Appearance time	Not catheterized	9 minutes
First fifteen minutes	Transvesical at end of fifteen minutes	1½ per cent
Second fifteen minutes	Showed only slight trace of phthalein	
Total		
Leakage		

April 23, 1920. Patient much more comfortable. Has no frequency nor pain following urination, as so badly complained of on admission.

A catheter previously placed in the ureter was frequently irrigated with argyrol, and on May 8 phthalein test showed by way of this catheter from left kidney—first hour, 10 per cent; second hour, 20 per cent; whereas by way of the bladder from the right kidney during the first hour only a faint trace was obtained, and in the second hour, 3 per cent.

Operation. (May 1.)

May 1, 1920. Operation: Left ureteropyloroplasty.

General condition: Good.

Reason for operation: Impaired kidney function.

Operation: Gas, oxygen and ether anesthesia. The field of operation was prepared with alcohol, ether and biniodid. An incision was made in the lumbar region just below and parallel to the twelfth rib on the left side. The kidney and its pelvis were delivered. There was very little kidney tissue left, the pelvis being markedly dilated. There were several tubercular nodules palpable in the kidney substance. Lobulation was very marked. There was a small constriction at the pelvic ureteral junction. This was divided transversely, the incision being sewed up so that the long axis of the wound was at right angles to its former position, the same as in a pyloroplasty. No. 00 chromic catgut was used. The ureter itself was the size of a fountain pen and apparently dilated for its entire length, as much foul-smelling urine flowed back from it on section. A small soft catheter was sewed into the ureter for irrigation. Closure was made in the usual manner, a rubber drain being inserted.

Condition of patient on leaving operating room: Good.

May 10, 1920. Stitches removed.

May 13, 1920. The drainage catheter in ureter was removed and the drainage through the lumbar incision gradually diminished, with a corresponding increase in urinary output.

May 15, 1920. Phthalein: First hour (600 cc. output), 10 per cent; second hour (200 cc. output), 15 per cent; total, 25 per cent.

May 18, 1920. Large ureteral catheters were inserted by cystoscope and retained during the next two days. Culture of the urine at this time, for the first time, showed B. coli. The ureteral catheters on each side were lavaged every three hours with 1 per cent mercurochrome.

May 21, 1920. Cultures: From right kidney showed B. proteus; from left kidney and bladder, B. coli, B. proteus, Streptococcus viridans.

May 23, 1920. Clinical condition has improved, evidence of less sepsis.

Phthalein: First hour, 20 per cent; second hour, 15 per cent; total, 35 per cent.

June 1, 1920. Temperature has gone down and clinical sepsis has been reduced. Culture from catheterized specimen of bladder shows B. coli and B. pyocyaneus.

Ureteral catheterization record

May 18, 1920

	RIGHT	LEFT	TRANSVESICAL
Kidney findings:			
Red blood cells	Occas. cell	Occas cell	None
White blood cells	Abundant	Abundant	Abundant
Casts	None	None	None
Epithelial cells	Much detritus 6 h.d.	10–12 h.d.	Debris—12–15 h.d.
Organisms	Rods	Rods	Numerous rods

June 3, 1920. Cystoscopy

Kidney findings:			
Red blood cells	0	0	0
White blood cells	Abundant (300 h.d.)	Abundant (250 h.d.)	200 to h.d. field
Casts			

Remarks: Retention catheter placed in each kidney pelvis.

June 1, 1920. Wound looks better. Anterior portion is about healed.

June 2, 1920. Phthalein: First hour, 30 per cent; second hour, 30 per cent; total, 60 per cent.

Catheters left in place for four days, during which time both kidney pelves were lavaged with mercurochrome every two to four hours.

June 7, 1920. White count, 11,000; 33 per cent small lymphocytes; 2 per cent eosinophiles; 56 per cent polymorphonuclears; 2 per cent fragmentary leucocytes; 4 per cent large lymphocytes; 1 per cent endocytes; 1 per cent Basophiles.

Phthalein: First hour, 30 per cent; second hour, 30 per cent; total, 60 per cent.

Physical examination shows heart and lungs in good condition for anesthetic.

June 11, 1920. Patient has been running a fever since operation but this is going down. Mercurochrome irrigations given through ureteral catheter every three hours. Wound is dry.

Phthalein: By way of bladder: First hour, 7.5 per cent; second hour, 10.0 per cent; total, 17.5 per cent.

Though catheter in right ureter: First hour, colored with mercurochrome; second hour, 2 per cent.

This test would show that the previous operated kidney is doing the major amount of work.

June 15, 1920. Ureteral catheter apparently not draining well. Irrigated and washed out. Wound at left side is a little raw and open.

June 16, 1920. Phthalein: Through ureteral catheter: First hour, 10 per cent; second hour, 15 per cent; total, 25 per cent.

Through bladder: First hour, 7.5 per cent; second hour, lost.

Wound dressed. Catheter removed from right ureter.

June 19, 1920. Wound dressed and remaining silk sutures removed.

July 3, 1920. Phthalein: First hour, 20 per cent; second hour, 10 per cent; total, 30 per cent.

Operation. General condition: Fairly good.

June 8, 1920. Second operation (right ureteropyeloplasty).

Reaon for operation: Hydronephrosis and pyelitis.

Operation: Gas and oxygen anesthesia. The field of operation was prepared with alcohol, ether and biniodid. After having the patient well on her left side and in good position so as to give a good exposure for a kidney incision, the usual incision was made just below and parallel to the twelfth rib on the right side. The kidney with its

pelvis and ureter was then fairly easily exposed and delivered. The kidney was found to be fairly well collapsed. The ureter was dilated about 0.75 cm. down as far as could be seen or felt. There was found to be a kink or constriction of the ureter at the uretero-pelvic junction. All the adhesions between the ureter and pelvis and the ureter and kidney were freed and a longitudinal incision made through the kinked area, which was sewed up so as to make the long axis at right angles to the line of incision, thus widening out the constriction. A small rubber catheter was then inserted down deep into the ureter through a previously made incision in the pelvis. A rubber tube and rubber dam drain were placed in the wound and the muscles and fascia closed with continuous no. 2 iodized catgut. The skin was closed with buttonhole silk sutures. Dry dressings applied.

Condition of patient on leaving operating room: Good.

July 8, 1920. During the last few days temperature has been up; highest, 39.9°. Patient feels fine other than loss of appetite. No pain.

Physical examination. Chest negative; respirations rapid, 26 per minute; heart negative, heart sounds negative; rate, 128 per minute: no murmurs. No tenderness or pain in abdomen.

Temperature gradually subsided within next few days.

July 11, 1920. Patient discharged. Temperature 37.2°.

August 9, 1920. Reëntry.

Past illness. Since discharged on July 11, 1920, the patient was doing better; gained 7 pounds during three weeks' time. Drainage from the wound was stopped. Voided about 40 ounces of urine a day, more or less clear. No pain in bladder or kidney region. However, between July 31 and August 5, she had fever (101); nausea and vomiting; was unable to retain food. Amount of urine decreased to 30 ounces and was more cloudy and had foul odor. Had pain over the umbilical region about half hour before the urination. These troubles had taken place just during those five days (July 31 to August 4). She has been well rest of days while at home.

Physical examination. Is essentially negative except that she is delicate, pale, anemic and highly nervous. General condition, however, is very much better now than when she left the hospital three weeks ago.

August 9, 1920. Phthalein: First hour, 25 per cent; second hour, 25 per cent; total, 50 per cent.

Urine: Cloudy, greenish gray. Specific gravity 1.006; alkaline albumen 0; sugar 0; abundant white blood cells; red cells 0; many rods and cocci.

Culture: Bladder, Streptococcus viridans; left kidney, Streptococcus viridans.

August 10, 1920. Cystoscoped. Catheter inserted into left kidney, which was retained for six hours, during which time three irrigations with 5 cc. of ½ per cent mercurochrome were given.

August 12, 1920. Right kidney catheterized and lavaged every three hours for a period of twelve hours, with 1 per cent mercurochrome.

August 14, 1920. Discharged.

August 17, 1920. Reëntry for observation.

August 18, 1920. Phthalein: First hour, 20 per cent; second hour, 10 per cent; total, 40 per cent.

Urine: Cloudy, yellow; alkaline albumen 0; sugar 0; casts 0; white blood cells abundant; red blood cells 0; abundant cocci and rods present.

August 19, 1920. Cystoscoped. Catheter introduced into left ureter. Mercurochrome instillation every three hours via catheter.

Culture: Streptococcus viridans.

August 22, 1920. Blood count: Hemoglobin 60 per cent; red blood cells 4,560,000; white blood cells 14,200; polymorphonuclears 64 per cent; S. M. 25 per cent; L. M. 9 per cent; eosinophiles 2 per cent.

August 22, 1920. Patient feeling well. Temperature almost normal since entry. General appearance good.

August 23, 1920. Patient discharged.

December 1, 1920. Reëntry for examination. Since last entry patient has gained 5 pounds. If she gets over-tired she complains of pain in pit of stomach and is nauseated. Usually gets up only once during the night to void. No hematuria; no burning on urination. Appetite good. Good control of urination. Bowels still constipated and patient continues with cathartics. Sleeps good. Much more active than ever before and does not tire nearly so easily. Lungs negative; heart, normal area of cardiac dullness; sounds of good quality and rhythm.

December 3, 1920. Phthalein: First hour, 20 per cent; second hour, 15 per cent; total, 35 per cent.

Cultures of catheterized urine show B. coli in all three specimens.

April 14, 1922. Patient has been recently heard from and has remained about the same as indicated by last note. No further cystoscopic studies or phthalein tests have been done.

Case 8. Female, age fifty. Admitted, August 16, 1921.

Complaint. Frequency, pyuria, night sweats.

Family history. No tuberculosis malignancy, mental disease. No renal disease except as terminal event.

Past history. Recently married. No children. Cta: Thirteen years 28/4, no clots, pain or leucorrhea.

Diseases: Measles, mumps, chicken-pox. No infectious diseases; no scarlet fever, diphtheria or pneumonia. Occasional sore throats and tonsillitis formerly. No C. R. history. Appetite good, weight maintained. Is constipated; taken no laxatives. Complains of dull oppressive feeling in epigastrium during past year, unassociated with eating, position. Not noticed as much when eating "light" food. No other G. S. history. Sleeps fairly well but of nervous disposition.

Past illness. Accidents: None.

Operations: Kidney fixation 1903, Portland, Oregon. Following operation, patient told that there was a "kink" in right ureter. Patient had no genito-urinary symptoms prior to kidney fixation, but mobile kidney on incidental finding in physical examination at that time. Four weeks following operation developed cystitis with burning, frequency and suprapubic tenderness. Treated at time with boric irrigations, argyrol and $AgNO_3$, and continuously for nine months. Following discharge had no further vesical symptoms or genito-urinary disturbance until onset of present illness. About June 10, patient noticed slight night sweats and a few days later began to have severe "urethral pain—not burning" at the end of urination. This became so severe patient called physician. She was taken to Ward Sanitorium and treated for B. coli pyelitis with vaccine and bladder irrigation. Following discharge in three weeks subjectively well until August 7, when patient experienced dull ache and throbbing over left lumbar region posteriorly. This lasted twenty-four hours and patient called physician, who gave hyperdermic. Kept on liquid diet in bed; felt well for a week and had a similar attack, lasting twenty-four hours. Given another hyperdermic, which did not relieve all pain. Following this patient had slight burning on urination. Noticed no frequency or other urinary disturbance. During both attacks patient vomited once. In interim had some fever and slight headache. No chills. Dr. Hinman called and patient entered hospital.

Physical examination. Fairly well developed and nerved woman. General appearance in keeping with age.

Skin clear. Right rectus scar and scar over right back.

Eyes, ears, nose: Externally negative.

Mouth, tongue and throat: Negative.

Chest: Walls symmetrical; equal movement and respiration.

Lungs: Resonant; no rales or changed breathing heard.

Heart: A. C. D. of usual dimensions; sounds regular in rate, force and rhythm but distant and feeble. No murmurs. Pulse (right) equal, synchronous, regular in rate, force and rhythm. Volume good and tension moderate. Blood pressure 120/80.

Abdomen: Symmetrical. No local prominence. Tenderness on deep palpation over left kidney. No tenderness over right on gentle palpation. No edema, induration, inflammation or neighborhood fluid.

Back: Scar as mentioned. No tenderness.

Extremities: Negative.

Reflexes: Arm and leg jerks of usual amplitude and equal. No pathological spinal tendon jerks elicited.

August 16, 1921. Patient to cystoscopy. Ureters catheterized. Pelves of kidneys drained. Both specimens exhibited marked pus content. Five cubic centimeters 0.5 per cent $AgNO_3$ injected into pelvis of right kidney and the left kidney catheter allowed to remain in place.

Phthalein:

	R	*L*
Appearance time	18	25
First fifteen minutes	6	Trace
Second fifteen minutes	Not collected	

August 17, 1921. Patient had good night. Catheter draining well. Night specimen about 20 per cent pus. Patient nearly afebrile today and fluids well taken. Subjectively well.

Culture urine both kidneys catheterized—B. coli. Vaccine 1 billion to cubic centimeter to be made.

August 18, 1921. Temperature, pulse and respiration normal this evening, though patient complains of pain over right kidney and is restless. Catheter removed following lavage this afternoon.

To cystoscopy. Kidneys catheterized to pelves; marked pyuria of right side; no drainage from left.

Blood: Urea nitrogen, 19.0 mgm. per 100 cc.; non-protein nitrogen, 40.0 mgm. per 100 cc.

August 19, 1921. Patient resting well.

Urine: 1.009, epithelial cells many; red blood cells, 0; white blood cells 50–60 h.d.; casts 0.

Phthalein: First hour, trace; second hour, 12 per cent.

August 21, 1921. Urine: Gross specimen shows great improvement; is cloudy with only about 5 per cent sediment. Specific gravity 1.01; acid; white blood cells 50 h.d.; red blood cells 0; casts 0.

August 30, 1921. Patient has been experiencing severe and aching pain over left kidney region, yesterday and today, with definite local tenderness anteriorly and posteriorly.

To cystoscopy. Both ureters catheterized. Only 2 cc. slightly cloudy urine from left side, with no subsequent drainage, so catheter withdrawn. Right catheter retained and lavaged with 1 per cent mercurochrome during morning and afternoon every three hours. Patient in considerable distress because of pain.

August 31, 1921. Patient nauseated during day. Has taken very little food. Output yesterday, 1800. Pain on left side absent today and patient more comfortable.

Phthalein: First hour, trace (about 10 cc. urine only in specimen); second hour, 5 per cent (very little urine—about 20 cc.).

September 2, 1921. Patient complains of slight urethral irritability today.

Phthalein: First hour, 15 per cent; second hour, 20 per cent; total, 35 per cent.

September 3, 1921. To cystoscopy. Right kidney pelvis lavaged with 1 per cent mercurochrome and repeated every three hours during day. Catheter withdrawn at 7:00 p.m.

September 6, 1921. No backache or renal pain during past three days. Sat up for fifteen minutes yesterday.

Urine specimens still very cloudy but show diminishing amount of sediment. Centrifuged specimen gives about 1/20 sediment.

Phthalein: First hour, 15 per cent; second hour, 20 per cent; total, 35 per cent.

September 7, 1921. Urine: Hemogeneous sediment about 1/20. Uncentrifuged specimen shows: White blood cells 2–4 h.d.; red blood cells 0; casts 0; epithelial occasional round cell.

September 9, 1921. To cystoscopy yesterday. Right kidney pelvis lavaged with mercurochrome. Catheter retained and lavaged every three hours during day. Urine shows considerable improvement over previous catheterized specimen.

September 12, 1921. Patient improved. Urinary output averages 1800. Specimens macroscopically show fine turbidity but greatly reduced amount of sediment, being 1/40 or less.

Urine in uncentrifuged specimen shows only occasional white blood cells in contrast to previous findings. Centrifugalized specimen shows field covered with white blood cells, epithelial cells and motile rods.

September 13, 1921. To cystoscopy this morning.

Ureteral catheterization record

September 13, 1921

	RIGHT	LEFT	TRANSVESICAL
Kidney findings:			
Size of catheter			No specimen
Distance inserted	Pelvis	Pelvis	
Character of flow	Continued	Continued	
Uncentrifuged:			
Macroscopic			
Microscopic			
Red blood cells	0	0	
White blood cells	6–8 h.d.	6–8 h.d.	
Casts	0	0	
Epithelial cells	Occas.	Occas.	
Organisms	Motile rods	Motile rods	
Stained smear			
Cultures: Right and left kidney, bladder			
Phthalein:			
Appearance time	8	8	
First fifteen minutes	5	Trace	1st hour, 20
Second twelve minutes	17	7	2nd hour, 15
Total	22	8	35
Leakage	Not collected		

Remarks: Both ureters catheterized and lavaged every three hours during day with 1 per cent mercurochrome.

September 13, 1921. Left pyelogram was made with sodium bromide, which is in every way similar with that reported of the right kidney (fig. 43).

September 14, 1921. Temperature, pulse and respiration normal. Patient fairly comfortable during early part of day. Experienced several short attacks of severe cramp-like pain along course of both ureters. Urinary output remains fairly high and character as previously noted. Slight turbidity with very little sediment now. Microscopic examination shows field covered with pus, cells and rods.

Phthalein: First hour, tinged with Hg 220 and phthalein precipitated (color of sediment indicates considerable phthalein present); second hour, 20 to 30 per cent, tinged slightly with Hg 220.

September 16, 1921. Phthalein: First hour, 10 per cent; second hour, 40 per cent; total, 50 per cent.

September 19, 1921. Phthalein: First hour, 25 per cent; second hour, 30 per cent; total, 55 per cent.

Culture: (September 15), B. coli in all three.

Urine: Slightly cloudy; albumen S. P. T.; white blood cells 40–50 h.d.

September 21, 1921. Urine culture: (January 17), B. coli.

Phthalein: First hour, 10 per cent; second hour, 30 per cent; total, 40 per cent.

September 23, 1921. Phthalein: First hour, 15 per cent; second hour, 20 per cent; total, 35 per cent.

Urine: Cloudy; albumen trace. Microscopic examination, white blood cells 15–20 h.d.; many motile rods.

Bladder urine culture: B. coli.

September 24, 1921. Right pyelogram, as shown in figure 38, was taken with sodium bromide 20 per cent. The enormous hydronephrotic sac is quite evident.

September 30, 1921. Phthalein: First hour, 20 per cent; second hour, 30 per cent; total, 50 per cent.

Urine culture from right and left kidney and bladder showed B. coli.

October 5, 1921. Temperature this morning, 37.7; pulse, 102.

(October 3.)

Reason for operation: Hydronephrosis and nephroptosis.

Operation. Pyeloplasty and nephropexy.

October 3, 1921. Operation, uretero-pyeloplasty and nephropexy. Patient was placed on her left side.

Skin cleaned with alcohol, ether and biniodid.

An incision was made parallel to and about 1 cm. below the left rib, extending from the subcostal angle behind and completely downward to the anterior iliac spine. The muscle layers were divided in the usual way and the perinephric fat identified. This was excised and the kidney exposed. A large hydronephrotic kidney was seen similar in outline in all respects to the x-ray plates. There was a very large extra-renal urine-filled pelvis and an elongated and broadened parenchyma. To the palpating finger the parenchyma seemed fully 3 cm. thick. The kidney was readily freed and the ureter identified and separated. A retaining tape was passed around it. The ureter was not greatly enlarged or thickened but its course ran obliquely forward from the posterior inferior aspect of the hydronephrotic sac. On reaching the anterior aspect of this sac the direction of the ureter changed abruptly downward toward the bladder. There was passed

to the operator a no. 00 black silk suture on a curved French needle. Beginning at the upper pole of the kidney at the junction of the pelvis and renal tissue proper this silk suture was placed in the outer fibrous

FIG. 38. Case 8. Left pyelogram (the right was in every way similar) showing huge bilateral hydronephrosis relieved in two stages by plastic operation and kidney fixation, with a more gratifying and remarkable result even than in case 7. Total function restored to normal and infection relieved.

coat of the pelvis at ½ cm. intervals, passing from one side of the kidney pelvis around the belly of the pelvis to the other side and back again. A second suture identical with this was placed toward the lower pole of the kidney just beyond the midline. These two sutures were then

drawn tightly and firmly tied. The knots were on opposite sides of the kidney pelvis. The result of drawing in these black threads was to cause an enfolding and tightening of the pelvis, reducing this pelvis space and permitting the free exit of urine down the ureter. With warm tape pads the kidney was now lifted up into the wound. Three sutures of braided silk were placed in the kidney substance with a large curved round needle running close to the capsule in mattress fashion. One of these was placed on each lateral aspect of the kidney in its lower pole and one in its upper pole on its convex border. They were then anchored deeply in the neighboring muscles, the one from the upper convex portion of the kidney being carried through the tissues between the eleventh and twelfth ribs. The deep muscles were then approximated with running locked sutures of no. 2 chromic gut. A second running suture of doubled no. 2 chromic was used to close the superficial muscles. Skin was closed with running locked sutures of black silk. Iodin was applied and the wound covered with gauze dressings. A small drain was allowed to protrude from the posterior edge of the wound.

Patient left the table in good condition.

October 5, 1921. Last night patient given pituitrin and abdominal massage with warm oil for gaseous distension, with considerable relief. Distension returned somewhat and was greatly relieved at 3 a.m. by milk and molasses enema. This morning distension much less than yesterday. Able to retain egg and toast.

October 15, 1921. Phthalein: First hour, 25 per cent; second hour, 30 per cent; total, 55 per cent.

October 19, 1921. Phthalein: First hour, 24 per cent; second hour, 30 per cent; total, 54 per cent.

October 26, 1921. Patient has not been feeling so well last few days. Urine is quite turbid, with heavy white sediment.

October 30, 1921. Phthalein: First hour, 17 per cent; second hour, 21 per cent; total, 38 per cent.

Patient allowed to take a few steps. Up in chair for part of an hour. Feeling well. All urine specimens show heavy mucous sediment; much pus.

November 18, 1921. Patient has gradually been getting stronger. Urine quite cloudy, showing pus.

Phthalein: First hour, 16 per cent; second hour, 33 per cent; total, 49 per cent.

November 19, 1921. Patient discharged.

January 23, 1922. Reëntry. During interval since last discharge patient has been under observation and has had several cystoscopic examinations, with ureteral catheterization and pelvic lavage. Her general health has been fair. Has gained thirteen pounds; walks about a little. Occasional dull pain in either loin and has light night sweats if she has overdone.

January 23, 1922. Phthalein: First hour, 23 per cent; second hour, 28 per cent; total, 51 per cent.

January 24, 1922. *Examination.* Lungs: Negative. Normal resonance, breath and voice sounds. No râles.

Heart: No symptoms. Sounds of good quality. Rate 84 per minute. Blood pressure: 130/82.

January 25, 1922. *Operation.* Right uretero-pyeloplasty and nephropexy.

Reason for operation: Infected hydronephrosis of right kidney.

General condition: Good.

Anesthesia: Gas and oxygen.

The patient was placed in the left lateral position with lumbar support. An incision was made parallel to and about 1 cm. below the twelfth rib in the region of a former scar of the same length, which ran somewhat transversely to the present incision. The cut was carried down to and through the muscles with a knife but was carried to the retro-renal region with scissors. The vessels were ligated with no. 00 iodized catgut and towels anchored to the wound edges. A number of adhesions were found comprising the retro-renal tissues. A small amount of retro-renal fat was seen as the fibrous tissue was separated. With warm tape pads the kidney was lifted up into the wound. A ½-inch gauze tape was passed beneath the ureter and grasped with a Kelly hemostat. The kidney was freed from the adhesions on all sides and there was found present a greatly dilated pelvis, which was extrarenal in type. The pelvis seemed to be divided extrarenally to the parenchyma into their limbs. A no. 10 soft rubber catheter was inserted through a stab wound into the pelvis. The contents of the pelvis were withdrawn through this catheter and were found to be full of flakey, blackish mucus. The catheter was then carried down to the ureteral pelvic juncture and passed 1 or 2 cm. into the ureter. A purse-string suture of black silk was carried around the kidney, threading itself just below the superficial layers or adventitia of the kidney pelvis. A second suture of this type was placed nearer the ureteral outlet and the two were drawn up so as to greatly narrow

the pelvis. A longitudinal slit was made at the ureteral pelvic junction and was closed transversely with an over-and-over running suture of no. 00 plain catgut. The kidney was then lifted up into the renal fossa, the ½-inch tape withdrawn from around the ureter and the kidney was fixed in its bed by means of three Pagenstecher sutures. The upper of these was placed in the upper pole of the kidney on the convex border; the others were placed in each lateral aspect of the kidney. They were anchored into the surrounding musculature, the upper one being placed between the two last ribs. A rubber drain was placed deep into the kidney fossa, with its lower end at the utero-pelvic junction. The wound was closed in two layers with no. 2 chromic catgut and with several subcutaneous retention sutures of no. 1 catgut. The skin was closed with black silk. The drain was allowed to protrude from the posterior angle of the wound. Gauze dressings were applied.

Patient left the table in good condition.

No specimen.

January 26, 1922. Patient has had little discomfort since operation. Catheterized once at 8:30 p.m. but has voided well since. Slight attack of gas pains relieved by eserine.

January 28, 1922. Condition good. Patient on whole comfortable. Irrigation through ureteral tube being kept up every three hours.

January 31, 1922. Sutures and drainage tube removed. Wound in good condition.

February 7, 1922. Incision has been closing by granulation. Still a small amount of sero-sanguineous discharge from middle and lower thirds and some slight leakage. Ureteral catheter placed well in ureter in an attempt to close the urinary fistula from right kidney. Catheter not open and could not be used as drain, so quickly withdrawn.

February 12, 1922. Eighteen days post-operative. No complaints. Urine output increased February 9 and drainage from wound has been gradually decreasing since. Output past twenty-four hours is 2500 cc., intake 2700. Very little drainage from fistula.

February 13, 1922. Phthalein: First hour, 15 per cent; second hour, 25 per cent; total, 40 per cent.

February 14, 1922. Urinary fistula has remained closed. No urinary leakage for two days.

February 20, 1922. Patient feeling well. General condition improving.

February 28, 1922. Phthalein: First hour, 30 per cent; second hour, 25 per cent; total, 55 per cent.

March 4, 1922. Patient discharged.

April 18, 1922. Since discharge patient has been seen several times and just recently has been cystoscoped and both ureters catheterized. The urine has completely cleared macroscopically but shows few pus cells microscopically and is positive on cultural study for B. coli. Patient's general condition is satisfactory; much stronger and has been running no temperature for months. Function remains between 50 and 60; and the right kidney at this time seems to have a somewhat greater output of phthalein than the left.

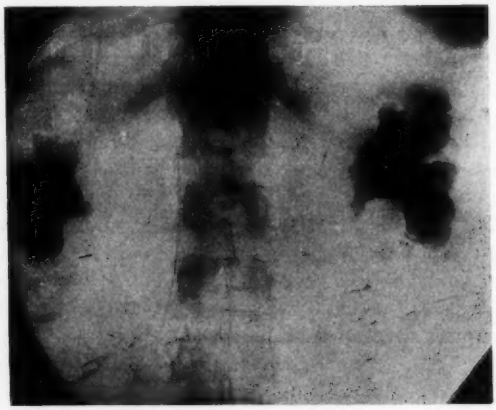


FIG. 39. Plain x-ray plate of a case, showing large stone casts of each pelvis. Pyuria for twenty years, with final marked renal insufficiency. Stones successfully removed by two separate operations. Renal function returned to normal and has remained so for four years.

Discussion. Cases 7 and 8 illustrate the remarkable possibilities of repair in hydronephrosis when there is a bilateral and even demand (also fig. 39). The different functional counterbalances that follow the respective repair operations is striking and give emphasis in addition to that of cases 4 and 5 of the danger of delay in the second operation.

VI. SUMMARY

Renal compensation has an important clinical significance and should be considered from an anatomical as well as func-

tional standpoint. Functional counterbalance has reference mainly to total function and in this limited sense counterbalance is complete whenever renal function is normal. But the anatomical changes may not be complete for many months or years later and therefore the process of an anatomical counterbalance has reference to the relative ability of a right and left kidney rather than to total function. Functional tests are of particular value as indication of relative strength but they do not permit an accurate anatomical correlation and therefore anatomical counterbalance is difficult of clinical application. The anatomical changes are gradual and progressive and cannot be definitely measured by relative function. Such tests, however, in conjunction with a knowledge of the pathology present in each kidney, help one to a fairly clear clinical inference of the compensatory changes and their present and potential extent. The end result, when the anatomical counterbalance may be said to have reached a stationary equilibrium, is primarily dependent upon the relative native or potential reserve strength of the two kidneys. When this is qualitatively equal an even or coöperative type of counterbalance results, but when unequal the nature of the competition created thereby causes growth by compensatory hypertrophy in response to increased functional activity or degeneration by disuse atrophy secondary to diminished or lost function.

Complete compensation in an anatomical sense may be used to define an unilateral compensatory hypertrophy of a functional degree and ability equal to that of two normal and healthy kidneys.

Partial compensation may be used to refer to the anatomical condition of a beginning but incomplete unilateral compensatory change and may occur under three circumstances: First, insufficient time for the development of a complete hypertrophy; second, no need for a complete compensation in view of considerable work still being performed by the other kidney; and third, inhibition of hypertrophy, or, rather, of an increase of function that would lead to hypertrophy, by the injurious action of the disease in it or in the opposite side.

What may be called renal decompensation or failure of a counterbalance will be indicated functionally by renal insufficiency and implies anatomically a condition in which compensatory changes cannot occur on account of the fact that renal tissue is already working to the height of its ability. These various considerations may be diagrammatically represented, as in table 2.

The surgical significance of the above experimental and clinical consideration would seem to be two-fold, in accordance to whether the surgeon is dealing with a unilateral or bilateral lesion, and may be summarized as follows:

1. It is useless to attempt preservation or repair of an unilateral injury in face of a healthy and complete compensatory hypertrophy on the opposite side. Therefore attempts to repair must be made before anatomical compensation is complete, and in distinctly unilateral lesions the outcome is always questionable because even a partial compensation of a healthy kidney may in time become complete through the competitive elimination of its less efficient repair mate. It is only in those conditions where the competition between the two sides is equalized qualitatively by the conservative repair procedure on the diseased side that a coöperative counterbalance can be expected.

2. In bilateral conditions conservation of renal tissue should always be given the greatest consideration. Conservative surgery in these cases will often give wonderful results. But in the event of a two-stage operative procedure, each kidney being treated at separate operations, which is almost always required, the second operation must not be too long delayed, because by the first one the previous equilibrium of competition has been overthrown and the repair on the side first operated may be so stimulated and efficient as to render the work of the unoperated and still inefficient side unnecessary. Delay will lead to its final atrophy from disuse.

3. In such a case of bilateral injury with a successful unilateral repair but in which there has been delay in the second operation, the problem may now closely simulate that of unilateral injury with opposite compensatory hypertrophy, and in place of a conservative procedure as originally planned, radical nephrectomy may be to the best interest of the patient.

TABLE 2

Native reserve with potential ability to do more work		Renal tissue	Reserve power absent, working to height of ability already	
A	*B*		*D*	*E*
Renal hypertrophy	Inhibition of hypertrophy	Demand for more work arises	Unable to hypertrophy	or Has reached maximum stage of hypertrophy
Partial or complete compensation with development of an acquired reserve	Renal insufficiency	Result	Insufficiency	Insufficiency
	Remove inhibiting factor			
	C			
	Compensation by hypertrophy			
		Competition in response to the demand for more work or as result of surplus of supply		

A with A or with C = Coöperative counterbalance.

A with B, D or E = Partial counterbalance of A, which in case of its marked superiority may lead to a complete compensation of A and a gradual disuse atrophy of B, D or E.

B with B = The anatomical change will be relative to the respective value and strength of each.

C with B = Same as A with B.

REFERENCES

ABELL, I. (50) Giant ureteral calculus; anomalous development of the genito-urinary tract. Surg. Gyn. & Obst., 1916, xxiii, 33.

ADAMI (125) Principles of Pathology, i, 801.

ALBARRAN (2) Étude sur le rein des urinaires. Thése, Paris, 1889. 184 p. 4°, no. 125.

ALBARRAN (3) L'hypertrophie compensatrice en Pathologie rénale. La presse Médicale, 1899, vii, 85, 22 février.

ALBARRAN ET BERNARD (4) Étude sur les cytotoxines Rénales. Arch. d. Med. Expér. et d'Anat. Path., 1903, xv, 13.

AMOS, B. C. (121) On the effect of ligature of one ureter. Jour. Path. & Bacteriol. (Edinb. and London), 1904, x, 265.

ANZILOTTI E FABRINI (5) Contr. sper. allo studio anat. pat. dell idronefrosi e pionefrosi. Pisa, 1902, 56.

ASCHOFF (74) Regeneration und hypertrophie. Ergebnisse d. allg. Path. v. Jahrg., 22.

BAINBRIDGE AND BEDDARD (110) The relation of the kidneys to metabolism. Preliminary communication. Proc. Roy. Soc. London, Series B, 1907, lxxix, 75.

BALLOWITZ (75) Ueber Angebornen, einseitigen, Vollkommenen Nierenmangel. Virchow's Arch., 1895, Bd. cxli, s. 309.

BARTH, A. (76) Ueber die Histolog. Vorgänge bei der Heilung von Nierenwunden und über die Frage des Wiederersatzes von Nierengewebe. Arch. für Klin. Chirurgie, 1893, Bd. 45, Heft 1, s. 192.

BECKMANN (77) (Cited by ALBARRAN).

BERNARD AND MEISSNER (118) (Cited by POUSSON).

BERTI, G. (97) Partial resection of kidney, experimental and clinical study. Policlinico (sez. chir.), 1921, xxviii, 261 (to be contd.).

BEUMER (78) Ueber Nierendefecte. Virchow's Arch., 1878, lxxii, 344.

BIZZOZERO E VASSALE (6) Sulla produzione e sulla rigenerazione fisiologica dégli elementi ghiandolari. Archivio per le Scienze Med., 1887, xi, 195.

BONARDI, M. (113) Influence de la Nephrectomie sur la resistance des Animaux aux infections et aux Empoisonnements. Archivio di Clinica Medica, Déc., 1892. Reviewed by Dr. E. Legram in Annales des Maladies de Organes Gen.-Urinaires, xii, 1894, 121.

BABOUREIX, L. Atrophie renale unilaterale. Gaz. d. hôp, Par., 1913, lxxxvi, 1965.

BRAASCH (102) Clinical notes on hydronephrosis. Interstate Med. Jour., St. Louis, 1914, xxi, 1180-88.

BRAASCH, WM. F. Atrophie pyelonephritis. Northwest Med., 1922, xxi, 1.

BROCA, M. (108) Hypertrophie Compensatrice du rein. Bulletin de la Sociéte Anatomique de Paris, 1889, lxiv, 18.

CARNOT, P. (7) Sur l'hypertrophie compensatrice du rein après néphrectomie unilatérale. Comptes rendus de la Soc. de Biologie, Par., 1913, lxxiv, 1086–88.

CARNOT, P. (8) Sur l'hyperplasie compensatrice du rein après action de divers agents thérapeutiques. Compt. rend. de la Soc. de Biol. Par., 1913, lxxv, 8–11.

CASTAIGNE AND RATHERY (105) Lesions des reins produites par injection d'emulsion rénale ou de serum nephrotoxique. Compt. rend. de la Soc. de Biol., 1902, liv, 563.

CASTAIGNE AND RATHERY (119) La Bordure en Brosse des Tubuli Contorti dans les Néphrites Expérimentales. Comptes rendus de la Soc. de Biol., 1902, liv, 1531.

CARREL, A. The ultimate result of a double nephrectomy and the reimplantation of one kidney. Jour. of Exp. Med., 1911, xiv, 124.

CASTAIGNE AND RATHERY (120) Toxicité de la Substance rénale et néphrotoxines. Presse Médicale, 1902, 13 Août, p. 771–775.

CHARCOT ET GOMBAULT (41) Prog. Med., 1878, 82.

CHAUFFARD (37) Traité de Médecine et la Semaine Médicale, before 1899. (Cited by POUSSON).

CLARK, H. C. (53) Renal anomalies that have occurred in the last 2823 autopsies at Ancon Hospital. Proc. M. Ass. Isthmian Canal Zone, Mount Hope, 1916, ix, pt. 2, 83–88.

COFFEY, R. C. Physiologic implantation of the severed ureter or common bile duct into the intestine. Jour. Amer. Med. Assoc., 1911, lvi, 397.

COHNHEIM (9) Berlin, 1882, Bd. 1.

COUNCILMAN (63) The pathology of the kidney, some general considerations. Jour. Amer. Med. Assoc., 1906, xlvi, 81–85.

DE PAOLI (104) Della Resezione del rene. Centralbl. f. Chir., 1892, xix, 78.

DONATI, M. (99) Ricerche sperimentali sul valore del trattamento conservativo dell'idronefrosi. Gior. d. r. Accad. di med. di Torino, 1904, 4. s., x, 597–612.

DONATI, M. (100) Contributo sperimentale allo studio dell'anatomia, fisiopatologia e Trattamento dell'idronefrosi. Clin. Chir. Milano, 1907. xv, 191: 273.

ECKARDT (10) Ueber die compensatorische Hypertrophie und das physiologische Wachsthum der Niere. Virchow's Arch., 1888, Bd. cxiv, s. 217.

EMGE, L. A. (47) A cytological study of the kidney cell in long continued hyperfunction with relation to hypertrophy and the mitochondrial apparatus. S. U. Pub. Univ. Series Med. Sciences, i, no. 2, p. 107.

ENDERLEN (79) (Cited by ALBARRAN).

FALK (80) Nierendefect. Virchow's Arch., 1881, lxxxiii, 558.

FIORI, PAOLO (11) L'ipertrofia anatomica e funzionale del rene e la tolleranza dell organismo nelle demolizioni estese dell' organo. Il. Policlinico, sez. chir., 1901, viii, 349: 428.

FIORI, PAOLO (12) Nefrectomia ed uretero-stenosi unilaterale. Il. Policlinico, sez. chir., 1903, x, 228.

FORTLAGE (45) Ueber die compensatorische Hypertrophie der Glomeruli bei Nephritis Interstitialis. Diss. Bonn., 1884.

GALEOTTI AND VILLA-SANTA (13) Ueber die Compensatorische Hypertrophie der Nieren. Beiträge zur Pathologischen Anatomie, 1902, xxxi, 120–142.

GERAGHTY AND PLAGGEMEYER (124) The practical importance of infantile kidney in renal diagnosis. Jour. Amer. Med. Assoc., Chicago, 1913, lxi, 2224–2228.

GHOREYEB, A. A. (14) A study of the circulation of the kidneys following ligation of one ureter. Jour. Exp. Med., 1914, xx, 191–200.

GIORDANO (114) At Plaisance in inter-provincial sanitary congress of upper Italy in 1908.

GOLGI, C. (38) Neoformazione dell'epitelio dei Canalicoli Oriniferi Nella Malattia di Brigth. Arch. per le Scienze Mediche, 1884, viii, p. 105, no. 5.

GOLGI, C. (81) Sur l'hypertrophie compensative des reins. Arch Italiennes de Biologie, Tome ii, 1882.

GOLDSCHMIDT AND PEARCE. Studies of metabolism in the dog before and after removal of the spleen. Jour. Exp. Med., xxii, 319.

GOLGI, C. (82) Sulla ipertrofia compensatoria dei reni. Arch. per le Scienze Mediche, 1883, vi, fac. 3, no. 20.

GORDINIER, H. C. (56) A case of unilateral hypertrophy of whole left side with autopsy. Albany M. Ann., 1918, xxxix, 47–57.

GRAWITZ AND ISRAEL (84) Experimentelle Untersuchungen uber Der Zussamenhang Zwischen und Herz Hypertrophie. Virchow's Arch., Bd. lxxvii, s. 315.

GRUBER AND BING (55) Uber Nierenmangel, Nierenkleinheit, Nierenvergrö-Berung und Nierenvermehrung. Ztschr. f. Urol. Chir., 6–7: 259, September, 1921.

GUDDEN (8) Ueber die Exstirpation der einen Niere und der Testikel beim Neugebornen Kaninchen. Virchow's Arch., Bd. lxvi, 55.

GUTTMANN (83) Virchow's Arch., 1883, xciii, 187.

HINMAN, F. (101) Experimental hydronephrosis, repair following ureterocysto-neostomy in white rats with complete ureteral obstruction. Tr. Sect. Genito-Urin. Dis. Am. M. Ass. Chicago, 1918, lxix, 103–117, 3 pl.

HIRSCH AND MASCHKE (122) Experimentelle Untersuchungen über Nephritis. Berl. klin. Wochenschr., 1912, xlxix, 145–147.

HUTCHINSON (57) A case of hemi-hypertrophy in which the internal organs were affected. Brit. Jour. Ch. Dis., 1904, i, 258.

JOHNSON (98) Renal function in experimental hydronephrosis. Jour. Exper. Med. Balt., 1918, xxviii, 193–212, 5 pl.

KARSNER, BUNKER AND GRABFIELD (60) A note on the immediate effects of reduction of kidney substance. Jour. Exp. Med., 1915, xxii, 544.

KÖSTER (42) Ueber Compensatorische Hypertraphieen in Atrofischen Nieren. Sitzungsherichten der Nieden Gesellschaft fur Natür. und Heilkunde, Juni, 1881.

KUMMEL (70) Verh. d. Gesell. Deutsch. Naturfortschr. u. Aerzte, s. 282, Bremen, 1898.

LANCEREAUX (86) (Cited by ALBARRAN).

LEICHTENSTERN (87) Ueber Nierenhypertrophie. Berl. Klin. Wochenschr., 1881, xviii, 484–505.

LINDEMANN (116) Sur le Mode D'Action de Certains Poisons Renaux. Annales de l'Institut Pasteur, 1900, xiv, 49.

LIPSKY (67) Ueber die Entzundlichen Veränderungen des Epithels der Harnkanälchen. Med. Jahrb., 1872, 155–159.

LOEB, L. (88) Further investigations on auto- and homoioplastic transplantation of kidney tissue. Jour. Med. Research, 1917, xxxvii, 229.

LORENZ (66) Zeitschr. f. klin. Med., Bd. x, s. 545.

LUSTIG AND GALEOTTI (89) Trattato di patologia generale. 3 ed. vi, Milano, 1911, Soc. Ed. Libraria 726, p. 4°.

LYON, M. (51) Two cases of congenital absence of one kidney. Jour. Amer. Med. Assoc., 1916, lxvii, 1524.

MAAS, H. (90) Klinische und experimentelle untersuchungen uber die subcutanen Quetschungen und Zerreissungen der Nieren. Deutsch. Zeitschr. f. Chir., 1878, x, 126–172.

MAUCHLE (107) Beitr. zur Kenatniss der Compensatorischen Hypertr. der Nieren. I. D. Zurich, 1894.

MOREL AND VERLIAC (15) L'hypertrophie renale Compensatrice. Compt. rend. Soc. de Biol. Par., 1913, lxxiv, 1202-1204.

MOORE, F. C. (52) The "unsymmetrical" kidney: its compensatory enlargement. Jour. Anat. & Phys., 1903, xxxviii, 71.

NAUWERCK (39) Ueber Endothelveränderungen bei acuter Nephritis. D. Med. Wochenschr., 1884, x, 145–147: 166–168.

NAUWERCK (40) Beiträge zur Kenntniss des Morbus Brightii. Ziegler's Beiträge zur Pathol. Anat. 1886, Bd. I, 1.

NÉFÉDIEFF (117) Sérum Nephrotoxique. Annales de l'Institut Pasteur, 1901, xv, 17.

NIGST, P. (58) Untersuchungen über Kompensatorische und Korrelative Hypertrophie. Schweiz. Med. Wchnschr., 1921, li, 155.

NOTHNAGEL (92) Ueber Anpassungen und Ausgleichungen bei pathologischen Zuständen. Zeitschr. f. klin. Med., 1886, xi, 82.

OLIVER, J. (85) Histogenesis of chronic uranic nephritis. Jour. Exp. Med., 1915, xxi, 425.

OLLIVE AND LEMEIGNEU (115) Précis sur les accidents du travail. (Cited by POUSSON.)

PEARCE (123) An experimental study of nephrotoxins. Univ. Penn. Med. Bull., 1903–1904, xvi, 217.

PEARCE (111) The influence of the reduction of kidney substance upon nitrogenous metabolism. Jour. Exp. Med., 1908, x, 632.

PERL, L. (93) Anatomische Studien uber Compensatorische Nierenhypertrophie. Virchow's Arch., 1872, lvi, 305.

PERUZZI (16) Lo Sperimentale, a. lxiv, fasc. 3°, p. 237.

PERUZZI (17) Ipertrofia ed iperplasia renale compensatoria. Sperimentale, Firenze, 1915, lxix, 247–288, 1 pl.

PETRONE (69) La rigenerazione del fegots e del rene per neoformazione dei loro dutti escretorio. Com. preven. Morgagni, 1881, fasc. 11–12.

PIERSOL (48) Human Anatomy, 1908.

PILCHER, J. (59) On the excretion of nitrogen subsequent to ligation of successive branches of renal arteries. Jour. Biol. Chem., 1913, xiv, 389.

PISENTI (18) Sur la cicatrisation blessures du rein et sur la régénération partielle de cet organe. Arch. Ital. de Biologie, Tome vi, 1884.

PODWYSSOZKI, W. (21) Experimentelle Untersuchungen uber die Regeneration der Drusengewebe. Ziegler's Beitrage z. Path. Anat. u. Allg. Path., 1886, 1, 259.

POUSSON, A. (19) The future of the nephrectomized. Amer. Jour. Urol., 1913, ix, 113–132.

POUSSON, A. (20) Beitrag zur Chirurgie der Nephritiden. Berl. klin. Wchnschr., 1913, i, 381–388.

RADASCH, H. E. (54) Congenital unilateral absence of the urogenital system and its relation to the development of the Wolffian and Muellerian ducts. Amer. Jour. Med. Sc., 1908, cxxxvi, 111.

RAYER (1) Traité des Maladies des reins. Paris, 1841, iii, par. 816.

REID, M. R. Uretero-venous anostomosis with observations on experimental hydronephrosis and the blood nitrogen. Bull. of the Johns Hopkins Hosp., 1918, xxix, 55.

RIBBERT (22) Compensatorische Hypertrophie der Harnkanälschen bei Nephritis interstitialis. Sitzungsber. d. Niederrh. Gesellsch. f. Natür und Heilkunde Juni, 1881.

RIBBERT (23) Ueber Compensatorische Hypertrophie der Nieren. Virch. Arch., 1882, lxxxviii, 11.

RIBBERT (24) Beiträge zur Kompensatorischen Hypertrophie und zur Regeneration. Archiv. für Entwickelungsmechanik der Organismen, 1895, i, 69.

RIBBERT (25) Das pathologische Wachsthum der Gewebe bei der Hypertrophie, Regeneration, Entzündung und geschwulstbildung. Bonn., 1896, F. Cohen, 102 p., 8°.

RIBBERT (26) Die Normale und pathologische und Anatomie der Niere. Bibliotheca Medica Abtheilung C. Heft 4, 1896.

RIBBERT (27) (Cited by ALBARRAN).

ROSE-BRADFORD, J. (109) The results following partial nephrectomy and the influence of the kidney on metabolism. Jour. Phys., 1899, xxiii, 415–496.

ROSENSTEIN (64) Ueber Complementäre Hypertrophie der Niere. Virchow's Arch., 1871, liii, 141.

ROWNTREE AND GERAGHTY (61) The phthalein test; an experimental and clinical study of phenosulphonephthalein in relation to renal function in health and disease. Arch. Int. Med., 1912, ix, 284–338.

SACERDOTTI (29) Ueber die Compensatorische Hypertrophie der Nieren. Virchow's Arch., 1896, cxlvi, 267.

SACERDOTTI (30) Sulla ipertrofia compensatoria dei reni. Arch. p. le Scienze Med., n. 3, 1896, xx, 245–276.

SCHWARZ, O. (112) Ueber die sogenannte "Reservekraft" der Niere. Ztschr. f. Urolog., 1919, xiii, 127.

SECHER, K. (49) Ueber Aplasia renis und venae cardinales resistentes. Berl. klin. Wchnschr., 1915, lii, 487–490.

SIMON (28) Chirurgie der Nieren. Erlangen, 1871–1876, s. 82.

SIMPSON, E. D. (68) The small kidney, with special reference to the new formation of tubules. Jour. Med. Research, Bost., 1914–1915, xxxi, 301–311, 1 pl.

STOERK (31) Zur Histogenese der Grawitz'schen Nierengeschwülste. Beitr. z. Anat. u. Allg. Path., 1908, xliii, 393–437.

STOSS (94) Deutsche Zeitschr. f. thiermed, u. vergleich., Path., Bd. xii, s. 284.

THOREL (46) Ueber typische und Pseudoregeneration bei Niereninfarkten. Virch. Arch., 1896, cxlvi, 297.

TILLMANS (73) (Cited by POUSSON).

TIZZONI AND PISENTI (71) Studi sperimentali sullo accrescimento fisiologico e patologico del rene. Arch. p. le Sc. Med., vi, 215.

TUFFIER, M. (33) Nephrectomie et résection partielles du rein—Pathologie expérimentale. Bulletines de la Société Anatomique de Paris, 1888, lxiii, 447.

TUFFIER, M. (34) Etudes Expérimentales sur la Chirurgie du rein, nephrectomie; néphrorraphie, nephrotomie; urétérotomie. Paris, 1889, G. Steinheil, 106 p., 8°.

VALENTIN (95) De Morbis nerv. cer. et. nerv. sympt. Bern., 1838.

VAN DER STRICHT, O. (65) (Cited by POUSSON).

VIRCHOW (35) Virchow Krankhafte Geschwülste, 1863, i, 267.

VITZOU, A. N. (106) Effets de l'extirpation partielle d'un rein suivie, un mois après de l'extirpation de l'autre. Compt. rend. de la Soc. de Biol., Par., 1901, liii, 1167–1169.

VOGEL (72) Krankheiten der Harnbereitenden Organe. Virchow Splz. Path. & Therapie, 1856–1865, Bd. vi, Abth. II, p. 413–708.

WALKER, J. (103) The early diagnosis of hydronephrosis by pyelography and other means. Ann. Surg., Phila., 1913, lviii, 766–799.

WEBER, F. P. (43) Compensating hypertrophy of renal secreting tubules in cases of granular contracted kidneys. The Practitioner, London, 1917, xcix, 260, 2 pl.

WEIGERT, C. (96) Die Bright'sche Nierenkrankung vom Pathologisch-Anatomischen standpunkte. Sammlung Klinischer Vortrage di R. Volkmann N. 162–163, 1879, 1411–1460.

WEILL, ANDRÉ (62) (Cited by O. SCHWARZ).

WOLF, M. (91) Die Nierensekretion und ihre Folgen. Berlin, Hirschwald, 1900.

WOSSIDLO, E. (36) Zur Funktion der Hypertrophischen Niere. Berl. klin. Wchnschr., 1914, li, 467.

ZIEGLER (44) Special Pathological Anatomy. 9th Ger. Ed., pp. 773–774, fig. 562.

DISCUSSION

Dr. J. T. GERAGHTY, Baltimore: Dr. Hinman's paper contains so much wonderful material, that, of course, it is impossible to speak of anything but a few points. I think that he has established some very fundamental things which we can utilize in our surgery and in our judgment of what we shall do with kidneys. I think that the point he brought out of waiting too long when we have bilateral disease before going after the second kidney bears considerable weight. The work not only shows beautiful experimental results but it has a great deal of practical value as its conclusions point out to you. There are a few points especially about the ability of the single kidney to take up the work of the other kidney. Our results with that were a little different from what Dr. Hinman has obtained. We found that if you had a continuous supply of normal functioning material established and take this supply with a steady output and then while the dog was under anesthesia do a nephrectomy, that at once the line of excretion scarcely changed at all, and the level attained the same level after the other kidney was removed. In Dr. Hinman's experiments I wonder if the operative procedure had not something to do with the temporary change in function. That is not saying that the possible total function of that kidney can be the same after nephrectomy; that is, the total that the kidney can be pushed to do, its maximum amount of work, but whether it cannot do its ordinary duty without substance in the blood or diminution in the output. I think our results differ slightly from those of Dr. Hinman. Perhaps he may have some explanation for it.

Now the disuse atrophy which follows pyelonephritis which cases Dr. Braasch has recently described—those cases have been somewhat of a puzzle to me. They are nearly always associated with bilateral pyelonephritis or if they are associated with only

a pyelonephritis of one side, there, of course, it is easy enough to explain the atrophy according to the experimental work of Dr. Hinman; but in my experience we find the condition atrophy on one side with pyelonephritis and diminished function, on one side no infection. Of course, there the explanation of disuse atrophy would not be available. It has been my opinion that in those cases we have originally had on one side an infantile kidney and on the other side a normal kidney and when the pyelonephritis comes and decreases the function on one side, it would naturally show marked atrophy when it was removed.

Dr. GUY HUNNER, Baltimore: We get some of our best opportunities to study the recovery powers of the kidneys in ureteral stricture work. Unfortunately it has not the beautiful accuracy that Dr. Hinman has shown us in his laboratory work, because we do not know how long the process has been going on. We can obtain from the patients how long they have had pain, but we get example after example where we are sure from the amount of destruction we find, as shown by the phthalein test and the pyelogram, that the patient has had his trouble much longer than we could conclude from taking the history. Another unfortunate circumstance from the experimental standpoint is that ureteral stricture is practically always bilateral, and we get examples similar to those described by Dr. Braasch of bilateral injury and of great atrophy on one side, and of only comparative atrophy on the other; or we get examples of bilateral hydronephrosis with tremendous destruction on one side and only comparative destruction on the other. So that it is difficult to draw as beautiful conclusions as Dr. Hinman has given us; but from the practical standpoint we do get a great deal of valuable information. For instance, a patient that came to me last October complained that for a year she had Dietl's crises on the right side. She was found to have a kidney holding 130 cc. on that side, and the left side held only 15 cc. The right side was putting out only the merest trace of phthalein, and the left side was putting out 15 per cent in a half hour after intravenous injection. Both sides had strictures. At the end of

one month after dilating the strictures the left side had jumped from 15 per cent to 30 per cent, and the other side had not changed. The patient was ambulatory during treatment. At the end of the second month the right side was secreting 5 per cent and then after resection of a portion of the pelvis and fixation of the kidney the right side increased to 14 per cent which was almost equal to the best side when she came in; and the left side came up to 32 per cent. We get a great many valuable illustrations from the purely clinical standpoint in these cases.

Dr. H. L. KRETSCHMER, Chicago: Dr. Hinman showed us that in some of his experiments in which he produced a hydronephrosis, he was able to cause the hydronephrosis to disappear, and that the kidney, to use a slang expression, "came back."

This same phenomenon can be observed clinically and I think the greatest example of the disappearance of a hydronephrosis is that seen during pregnancy. While I do not wish to advocate routine pyelograms in pregnant women, we have in several instances made pyelograms in cases of pyelitis of pregnancy. These showed enormous dilatation of the ureters and kidney pelves. After the uterus was emptied, these hydroureters and hydronephroses very rapidly disappeared so that pyelograms made ten days later showed a return almost to normal.

Clinical experience, therefore, bears out Dr. Hinman's statement that in his experimental work he has seen these hydronephroses disappear.

Dr. HAGNER, Washington, D. C.: This is one of the best papers I have heard read before this Society. It has a great many valuable points. The point the Doctor brought out concerning the amount of regeneration the kidney can make if the total deduction has not lasted too long. Some few years ago I had a case demonstrated that very well in a girl who had one kidney removed for tuberculosis, subsequently its fellow became tuberculous, and for several days before I saw her she had practically complete anuria. On catheterization it was possible to get to the kidney pelvis but there was no urine found. There was some

obstruction in the ureter and if the catheter were left in place urine would begin to secrete.

We did a nephrotomy on the remaining kidney, and she began to secrete urine. This girl lived three years with tuberculosis of her only remaining kidney, all the urine passing through a tube in the pelvis.

Dr. WILLIAM F. BRAASCH, Rochester, Minn.: Dr. Hinman's paper is encyclopedic so that it is impossible to discuss it fully. I would like to ask him if in the cases of compensatory hypertrophy the hypertrophy was not in the actual increase in capacity of the remaining glomeruli and secretory elements, or was there actual regeneration of these elements.

Dr. HINMAN: There is always a hypertrophy and never a regeneration.

Dr. BRAASCH: I would like to speak briefly on the subject of atrophic pyelonephritis which I described recently and to which Dr. Hinman referred. This condition should not be confused with unilateral nephritis. The condition is the result of an unusual form of acute and chronic unilateral renal infection. On the other hand, it is not the end result of the ordinary form of pyelonephritis which usually occurs bilaterally in its chronic form. It is difficult to determine the exact etiologic factors. The condition is evidently the result of successive infarcts or septic emboli which result in the cicatricial atrophy of a greater or less portion of the kidney involved. It is not secondary to the hydronephrosis which is often present, since the pelvic dilatation is always slight and the atrophy of the calyx resulting from hydronephrotic pressure is not present. The condition is accompanied by pathognomonic clinical data which were described at length in my paper.

Dr. JAMES A. GARDNER, Buffalo: I would like to ask the doctor whether, if two-thirds of the kidney tissue is sacrificed, the kidney can function sufficiently to keep the animal alive. Has

there been experimentation or will the remainder of the kidney hypertrophy and enough tissue remain so that at some time,—one, two or three months, more of the kidney tissue be sacrificed and the animal survive? Does the hypertrophy continue indefinitely?

Dr. ARTHUR L. CHUTE, Boston: I want to express my appreciation of Dr. Hinman's paper which is of the greatest interest to me. It goes a long way toward explaining certain things that have always puzzled me. For instance, we open up and drain a kidney that is not very extensively diseased and that we feel ought to do perfectly well but it goes on to suppuration and final atrophy. We operate upon another under similar circumstances and it regains its health and function well. Presumably in the instances in which the injured kidney atrophies there is so much good secreting tissue in the other side that the diseased kidney is not stimulated to its utmost to conserve its strength. This would also seem to explain why some patients in whom I have opened and drained the only remaining kidney have recovered with little apparent loss of function.

I wonder whether from the therapeutic point of view it would be of advantage to put the output of urine immediately when we operate upon a diseased kidney in a patient who has another normal kidney, whether perhaps forcing the patient to pass 150 to 200 ounces (nothing more than is easy for one kidney to pass), would have the effect of making the diseased kidney do all the work it could and thus favor to the greatest possible extent its regeneration.

Dr. WILLIAM C. QUINBY, Boston: I am sure the Society is to be congratulated on Dr. Hinman's paper, and I think this paper should be grouped together with the work of Dr. Richards on on kidney function which was demonstrated a day or two ago at Philadelphia. Dr. Hinman has raised questions of fundamental physiological and biological character; questions which are intimately related, I feel, with the question of growth and cessation of growth; atrophy. There are so many complicating

factors involved that I think we must be very careful in the deductions which we draw. If I may anticipate Dr. Hinman's answer to Dr. Gardner, I once tried to remove as much kidney tissue as possible within the factor of safety and then after the remaining tissue had become hypertrophic to remove some more. I was unable to find that the minimum amount of renal tissue was in any way altered by the hypertrophy in the work I did, and my feeling at the time was—and I see no reason to change it—that the gross hypertrophy of the individual cell of the tubules is not necessarily an indication of increased function of that cell. If you recall Dr. Richards' statement, you will remember that all of the kidney tissue is not at work at the same time, and that is true after a part of the kidney has been resected as well as of a normal kidney. So I doubt, that the hypertrophy of the system of tubules means an ability of that cell to produce more work. It may be a response to blood vascular changes or to something of that sort.

Dr. Frank Hinman, San Francisco: In answer to Dr. Geraghty's question with regard to the functional results in dogs relative to renal reserve, the experiments which I have referred to were controlled with respect to the influence of the trauma of operation. Other investigators have tested the effects of anesthetics upon renal function, and an extensive study has been made of the influence, for example, of splenectomy. Our own dogs were controlled by studying the effects with ether without operation in one series and in another series we gave ether and opened the abdomen as if we were going to do nephrectomy. The change in the phthalein output in the first few days after nephrectomy is very slight, but there is a definite degree of insufficiency in the first few days which is best shown by giving an overload, as for example, one kidney at first is unable to put urea out in anything like the normal time that two will.

Dr. Braasch raised the question of regeneration versus hypertrophy. I have not spoken of that though it is dealt within the paper. The literature is loaded with reports on this subject, and the mass of the literature with reference to compensation

is relative to this question. Councilman showed that the kidney has embryonic rests up to the fifth year of life, and in these cases where they are supposed to have regeneration of renal tissue there is a further development of these embryonic rests. Such a thing as real regeneration of kidney tissue does not occur after chemical damage or infection. You often get epithelial buds thrown off from the tubules but they do not connect up with glomeruli. The evidences of regeneration are really nothing more than connective tissue reaction to inflammatory irritation; and I think it has been definitely shown that regeneration does not occur except in very young animals or individuals.

With respect to Dr. Gardner's and Dr. Quinby's question as to the amount of tissue necessary for life and whether you can get further hypertrophy after an initial hypertrophy; there have been a number of experiments reported in the literature to show that often the initial hypertrophy can be increased by a further removal of kidney tissue. I forget the reference of a doctor who showed that he could remove a third of the renal mass and then remove another portion so that in the end he removed three quarters rather than two thirds, and the animal was living on one quarter of his original renal tissue.

Dr. Chute raised the question of overload, of putting an overload on kidneys to see if you could stimulate hypertrophy. There has been some interesting work done on this problem by Addis of San Francisco in conjunction with Emge. They fed rabbits large quantities of urea and failed by this means to produce hypertrophy of the kidneys. The experiment of Sacerdotti in which he injected the blood of nephrectomized dogs into a dog previously bled and produced bilateral hypertrophy is of interest. Clinically diabetes insipidus or diabetes mellitus do not cause renal hypertrophy. Enormous quantities of water are being poured through the kidneys so that it is questionable whether water puts much work on the kidneys.

Dr. James Pedersen, New York: I am sure I speak for the Association in complimenting Dr. Hinman for doing this important work and for presenting it to us.

REPORT OF CASES OF MALIGNANT GROWTHS OF THE BLADDER TREATED BY RESECTION AND RADIUM

HENRY G. BUGBEE

New York, New York

Received for publication August 10, 1922

With the discovery by Beer that benign papillomata could be destroyed by fulguration, it was hoped that malignant growths could be eliminated by the same or similar methods, the dealing with such tumors by surgery alone having been unsatisfactory in many cases.

Fulguration proved to be of little benefit and often a menace in dealing with malignant tumors of the bladder. It caused slight destruction of tissue in some cases, stimulated others in their growth, and led to infection, while valuable time was lost to other methods, which might have proved beneficial.

Diathermy and x-rays were given a trial, with slight success, and were abandoned, to be resurrected again during the past few years, the latter in the form of more powerful machines with deeper penetration. This work is still highly experimental. We will await clinical reports with interest and hope.

Radium was taken up as an agent of destruction of malignant bladder tumors. It was first applied, through variously modified cystoscopes, directly to the tumor. In but few cases was this method of treatment satisfactory. We were not sure of the pathology or extent of the growth we were treating. The application was on the surface, was of short duration, and caused discomfort at the time of application. Bladder irritability was often increased. These cases, however, showed that there was some effect upon the tumor which was beneficial.

In glancing over the report of Gardner (1), a collection of 1702 cases of bladder tumor treated by operation at the hands of various surgeons, one is impressed with the almost uniformly fatal results within from one to two years in cases treated by operation only.

A combination of radium and surgery was the next step, and the question now before us is just how valuable an accessory to surgery radium will prove to be in these cases.

In my own experience of the past two years, embracing but 19 cases, all treated by suprapubic cystotomy—in 2, the extensive infiltrating carcinoma largely destroyed by actual cautery and the base treated with radium; others treated by resection only; several by radium without resection, and the majority by resection and radium—certain points have been impressed upon me which seem worthy of report.

Of these 19 patients, 14 were males, 5 females. Their ages were forty to fifty, 4; fifty to sixty, 7; sixty to seventy, 5; seventy to eighty, 2; eighty to ninety, 1.

All of the patients had hematuria, the duration of which varied from two weeks to two years. They were free from urinary symptoms—urgency, frequency, painful urination—or these symptoms were distressing.

But 2 patients had maintained their weight; the others had lost from 5 to 25 pounds, the average being a loss of 15 pounds in six months.

Six of the cases presented a papillomatous growth; 13 an infiltrating growth, unquestionably cancer from the cystoscopic picture. In 4 of the papillomatous growths, where a possibility of its being benign was entertained, fulguration was first attempted, in each case the growth showing no response. All of the 19 cases proved to be malignant.

The test of fulguration upon a papilloma is often valuable in establishing a diagnosis. If a papilloma does not respond to fulguration at once it is probably malignant, and the bladder should be opened without delay. The histological study of the pathology of the growths has been interesting. Where doubt existed as to the nature of the growth removed, or sections taken

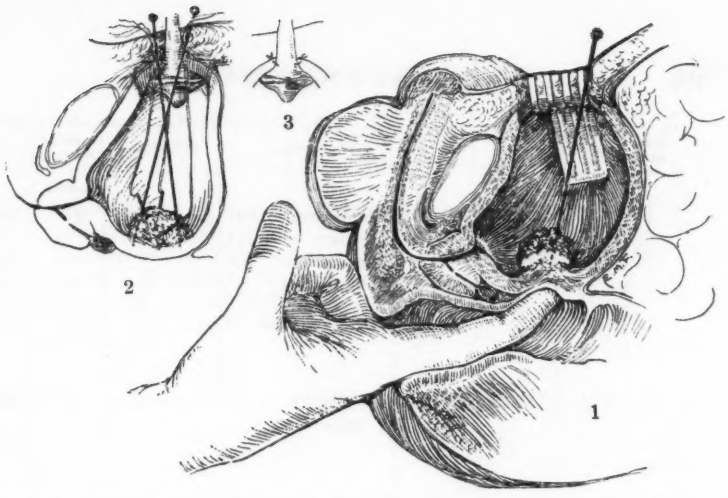


FIG. 1. METHOD OF INTRODUCING RADIUM NEEDLES INTO BLADDER GROWTH THROUGH SUPRAPUBIC OPENING

FIG. 2. RADIUM NEEDLES IN POSITION
Wound closed about drainage tube

FIG. 3. DRAINAGE TUBE SUTURED IN POSITION TO PREVENT DISPLACEMENT UPON WITHDRAWAL OF RADIUM NEEDLES

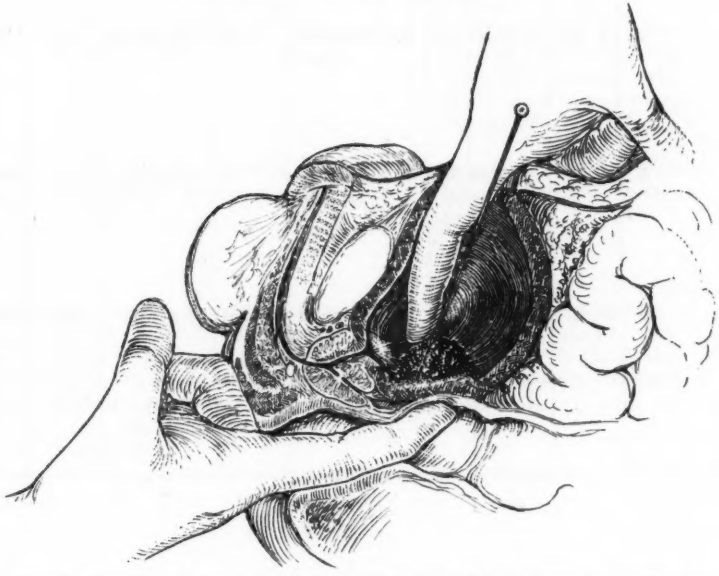


FIG. 4. METHOD OF REINTRODUCTION OF RADIUM NEEDLES THROUGH SUPRAPUBIC FISTULA

NUMBER	PATIENT	DATE	SEX	AGE	SYMPTOMS	HEMATURIA	LOSS OF WEIGHT	CLASSIFICATION OF TUMOR	OPERA
							pounds		
1	A. C.	4/20/20	M.	41	Frequency, urgency, painful urination for 9 months	9 months	15	Diffuse, infiltrating carcinoma involving base and vesical neck	Suprapub totomy structio growth rous c bladde cautery
2	H. L.	7/1/20	F.	52	Frequency of urination	7 months	18	Infiltrating carcinoma of fundus o bladder	Wide rese bladde
3	J. K.	7/1/20	M.	51	Frequency, urgency, painful urination for 7 months	7 months	10	Infiltrating carcinoma of bladde wall about blad der neck	Suprapub totomy um. suprap totomy month
4	J. M.	7/12/20	M.	63	Frequency of urination	2 months	18	Infiltrating carcinoma of anterio bladder wall	Wide res bladde
5	A. S.	9/7/20	M.	68	Frequency of urination	2 weeks	5	Papillary growth i fundus of bladde	No resp fulgura Resect bladde um nee
6	F. B.	9/13/20	M.	44	Frequent painful urination for 2 years	2 years	20	Diffuse infiltratin carcinoma of bas and vesical neck	Suprapu totomy structi growth rous co bladde cauter

OPERATION	RADIUM	SPECIMEN	RESULTS
Suprapubic cystotomy. Destruction of growth to serous coat of bladder with cautery	100 mil. applied to base of growth through suprapubic wound for 6000 mil. hours. Endovesical applications for 450 mil. hours. Per rectum 600 mil. hours	Carcinoma	Wound healed. Died of general metastasis 9 months after operation
Wide resection of bladder	None	Carcinoma	Wound healed. Free for 4 months. Recurrence extensive. General metastasis. Died 7 months later
Suprapubic cystotomy. Radium. Second suprapubic cystotomy 10 months later	Radium needles inserted into 4 nodules, 12½ mil. each. Endovesical applications, also rectal applications. Needles again inserted into recurrences at second operation	Adenocarcinoma	Wound healed. Bladder irritability persisted. 4 months after second operation general metastasis. Died
Wide resection of bladder wall	Radium packs, 400 mil. for 24 hours, 3 packs	Carcinoma	Wound healed readily. Implant in scar disappeared after first pack. Well. Free from recurrence. Patient well, 3/15/22
No response to fulguration. Resection of bladder. Radium needles	3 needles about line of resection of pedicle, 3 hours	Early malignancy	Wound healed readily. Free from recurrence today. Patient well, 3/15/22
Suprapubic cystotomy. Destruction of growth to serous coat of the bladder with cautery	Radium applied to base of growth through suprapubic wound, endovesically, and per rectum, 4800 mil. hours, 600 mil. hours, 800 mil. hours, respectively	Carcinoma	Wound healed. Bladder irritability persisted. Recurrence in bladder. General metastasis and death in 9 months

NUMBER	PATIENT	DATE	SEX	AGE	SYMPTOMS	HEMATURIA	LOSS OF WEIGHT	CLASSIFICATION OF TUMOR	OPE
							pounds		
7	A. R.	9/24/20	F.	54	Frequency, urgency, for 3 months. Cancer of breast removed five years previously	3 months	10	Infiltrating carcinoma of fundus bladder	Suprapu totom um
8	G. M.	12/29/20	M.	56	Urgent, frequent, painful urination for 2 years	Intermittent for 8 months	5	Infiltrating carcinoma of base bladder and tr gone. Individual nodules	Suprapu totom um
9	G. S.	1/ 1/21	M.	84	Frequency for 1 year	1 year	15	Infiltrating carcinoma of base bladder	Suprapu totom um
10	H. S.	1/24/21	M.	74	Frequency and urgency for 2 years	2 years	25	Infiltrating carcinoma of enti bladder base an right lateral wa	Suprapu totom um
11	J. D.	7/10/21	M.	50	Frequency, urgency	1 year	15	Papillary grow infiltrating bla der about vesic neck and involving left later wall	Suprapul totom um

OPERATION	RADIUM	SPECIMEN	RESULTS
Suprapubic cystotomy. Radium	3 radium needles, 12½ mil. each, inserted into growth (4 hours). Nodule, 1½ cm. in diameter, after surface applications through cystoscope. 5/17/21, reappeared and needles inserted (4 hours)	No section removed. Typical infiltrating cancer	2/19/22. Bladder reopened for supposed recurrence. Incrustation found at site of former growth. Bladder free of growth. Patient well, 3/15/22
Suprapubic cystotomy. Radium	10 radium needles, 2 of 25 mil., 4 of 12½ mil., and 4 of 10 mil., each inserted into nodules (4 hours). Recurrence, bladder reopened and 4 needles inserted into nodules (3 hours)	Carcinoma	Wound healed. Bladder irritability persisted. Recurrence. Bladder reopened one year later. General metastasis
Suprapubic cystotomy. Radium	3 radium needles, 12½ mil. each, inserted into growth. Repeated one month later (4 hours). On three repeated examinations no growth visible or palpable	Carcinoma	Patient died of pneumonia 1 year later. Bladder removed and found free of growth. 2/15/22
Suprapubic cystotomy. Radium	8 radium needles inserted into bladder base (6 hours), 2 of 25 mil., 4 of 12½ mil., 2 of 10 mil. 4 needles inserted through suprapubic wound, 1 month apart for 3 applications; 3 needles for 2 applications 2 months apart, and 1 of 2 needles	Carcinoma	No hard growth palpable. Bladder base edematous. Wound healed. Partial incontinence. 3/15/22
Suprapubic cystotomy. Radium	12 radium needles inserted, 2 of 25 mil., 4 of 12½ mil., 2 of 7 mil., for 6 hours	Adenocarcinoma	Wound healed. Free from growth by inspection and intravesical palpation 6 months later. Patient well. Free from growth. 4/19/22

NUMBER	PATIENT	DATE	SEX	AGE	SYMPTOMS	HEMATURIA	LOSS OF WEIGHT	CLASSIFICATION OF TUMOR	OPERA
							pounds		
12	S. S.	7/26/21	M.	74	Frequency, urgency	2 years	10	Large infiltrated carcinoma of left lateral wall and base of bladder	Suprapub totomy um
13	D. R.	7/26/21	M.	44	Frequency	9 months	5	Papilloma attached to trigone close to right ureter	Vesical pa respond once to ration. pubic omy 9 later
14	S. D.	9/12/21	F.	61	None	9 months	10	Malignant papilloma	No resp fulgura Resect bladde um
15	E. R.	9/17/21	F.	58	None	7 months	None	Infiltrating carcinoma	Resectio der.
16	J. W.	11/11/21	M.	65	Frequency	2 weeks	None	Malignant papilloma	Resectio der.
17	M. Y.	1/27/22	M.	48	Frequency, urgency	15 months	5	Malignant papilloma	No resp fulgura Resect bladde um
18	C. R.	1/31/22	M.	52	Frequency, urgency	2 years	10	Infiltrating carcinoma, entire base	Suprapul totom um
19	S. O.	2/10/22	F.	63	Frequency, urgency	15 months	15	Infiltrating carcinoma, extensive, growths	Suprapu totom um

OPERATION	RADIUM	SPECIMEN	RESULTS
Suprapubic cystotomy. Radium	10 radium needles inserted, 2 of 25 mil., 4 of 12½ mil., and 4 of 10 mil., for 6 hours	Carcinoma	Bladder free of growth. Patient well. Wound healed. 4/15/22
Vesical papilloma responded at once to fulguration. Suprapubic cystotomy 9 months later	2 radium needles of 25 mil. inserted through bladder base into perivesical growth	Carcinoma	Treated by fulguration 4/9/21. Rapid disappearance of growth. Occlusion of right ureter. Right nephrectomy. Suprapubic cystotomy. No bladder growth. Rapid perivesical growth of carcinoma and death from metastasis
No response to fulguration. Resection of bladder. Radium	4 radium needles, 10 mil. each, inserted about line of resection for 4 hours	Early malignancy	Wound healed. No recurrence to date. Slough in needle wounds for 3 months. Patient well, free of growth 4/18/22
Resection of bladder. Radium	4 radium needles of 12½ mil. each, inserted about line of resection of growth for 5 hours	Carcinoma	Wound healed. No recurrence to date. Slough in needle wounds for 4 months. Free of growth 3/16/22
Resection of bladder. Radium	3 radium needles of 10 mil. each inserted about line of resection for 4 hours	Carcinoma	Wound healed. No recurrence to date, 4/10/22
No response to fulguration. Resection of bladder. Radium	4 radium needles of 10 mil. each inserted about line of resection for 3 hours	Early malignancy	Wound healed. No recurrence. Sloughs about needle wounds still present (3 months) 4/16/22
Suprapubic cystotomy. Radium	6 radium needles, 1 of 25 mil., 2 of 12½ mil., and 3 of 10 mil., inserted into the growths	Carcinoma	Drainage tube in position. Growths markedly diminished in size, 4/10/22
Suprapubic cystotomy. Radium	8 radium needles, 2 of 12½ mil., 4 of 10 mil., and 2 of 7 mil., inserted into the two infiltrating growths	Carcinoma	Drainage tube in position. Growths diminishing rapidly 4/19/22

for diagnosis, the same section or sections from different parts of the growth have been submitted to more than one pathologist. In several instances one pathologist has reported no malignancy while another, in the same case, has reported carcinoma. This means either a different classification of bladder tumors by individual pathologists, or malignancy in isolated areas of the growth.

The accompanying chart gives the important points in these cases.

TO SUMMARIZE THESE CASES

The 2 cases treated by suprapubic cystotomy, actual cautery destruction of growth, and radium (cases 1 and 6) were hopeless cases from the start. The growth was very extensive, and there were signs of metastasis. Both men were young, forty-one and forty-four years of age, and it was an attempt to do something for their relief, the symptoms being most distressing.

The female with the infiltrating carcinoma (case 2) of the fundus of the bladder, was in perfect health for four months after operation when, within three weeks' time, a very extensive recurrence appeared in the bladder and abdominal scar, although the resection had been a wide one, with 2 cm. of healthy bladder on every side of the growth. She rapidly developed metastasis.

Case 3 presented small indurated nodules which proved to be adenocarcinoma. Although the nodules disappeared readily under the radium, others appeared and the growth metastasized rapidly.

Case 13 was a benign papilloma with a malignant base. The intravesical portion of the growth disappeared rapidly under fulguration, while the base extended along the outer bladder wall, completely surrounding the bladder, occluding the right ureter, and appearing in the anterior abdominal wall. Metastases developed rapidly.

In case 4, the growth, a large infiltrating cancer of the anterior bladder wall, was eliminated by resection and the implant destroyed readily by radium pack.

In cases 7, 9, 10, 11 and 12, of infiltrating carcinoma, the bladder was freed of growth by destroying the growth with radium needles, in the first 3, repeated introductions being necessary. In cases 18 and 19, recent cases, the growths are rapidly receding.

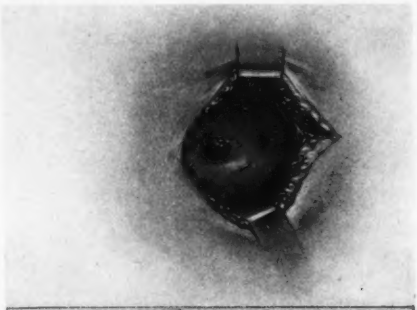


FIG. 5

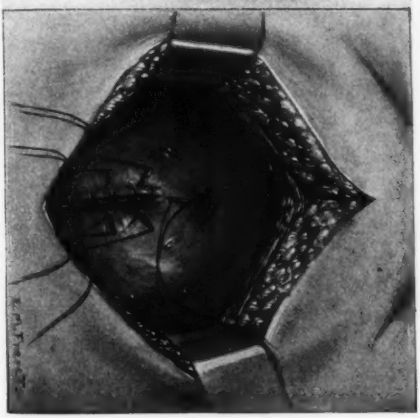


FIG. 6

FIG. 5. CASE 15. CARCINOMA OF THE BASE OF BLADDER

FIG. 6. CASE 15. RADIUM NEEDLES INSERTED ABOUT LINE OF RESECTION

In case 8, isolated infiltrating growths recurred and metastases have been present for one year.

In case 15, infiltrating carcinoma treated by resection and radium, needles being inserted about the line of suture, the

bladder has been free of recurrence for seven months. The histological sections in this case showed a rapidly growing carcinoma, strains of cancer cells extending along the muscle bundles.

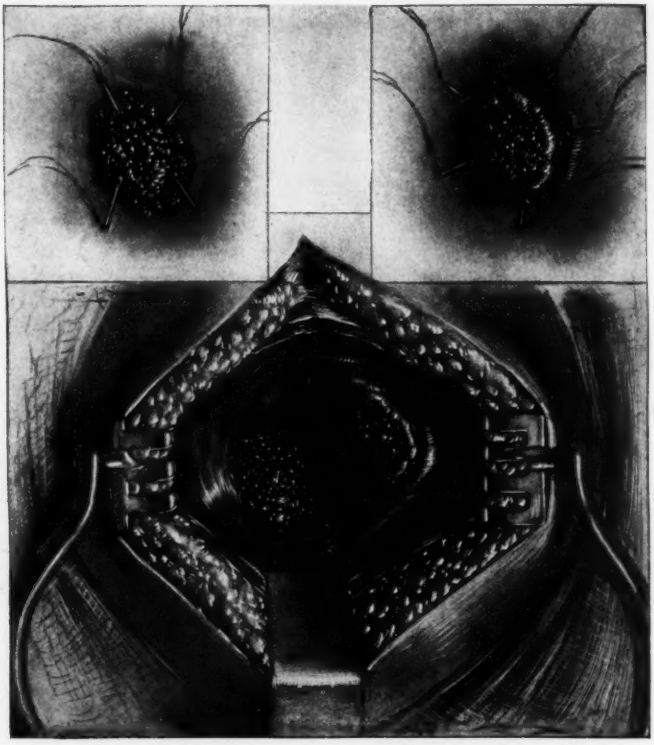


FIG. 7. CASE 19. TWO INFILTRATING GROWTHS OF BLADDER BASE
Insert shows radium needles in position

In cases 5, 14, 16 and 17, malignant papillomata, resection supplemented by radium needles about the line of resection, has given in each case a bladder free of growth to date.

SUMMARY

In cases of extensive carcinoma of the bladder, when metastasis has taken place, one's effort should be directed toward making the patient as comfortable as possible. Often this may best be attained by simple bladder drainage.

In extensive carcinoma of the bladder without metastasis, in lieu of total or subtotal cystectomy, it is possible in some cases to destroy the growth by repeated insertions of radium needles—*if* one bears in mind that he is trying to destroy the growth, not the patient, *by not too massive* a dose, but by repeated insertions at sufficient intervals, giving free bladder drainage to allow for sloughing and infection, every effort being exerted during the process to increase body elimination.

A circumscribed carcinoma should be removed by resection, if possible. Recurrences after operation are less resistant than the primary growth, sometimes yielding even to fulguration. A careful watch of all cases following operation, should be maintained that recurrences may be detected as early as possible, and destroyed, thus minimizing the chances of metastasis.

The insertion of radium needles into the bladder wall about the line of resection causes the formation of sloughs which have in some cases remained for four months. Such a procedure is valuable in minimizing the chances of local recurrence by destroying stray cancer cells and involves no risk or discomfort.

Malignant papillomata should be removed by resection, the line of resection being fortified by the insertion of radium needles.

While the cases reported are too recent to warrant the drawing of conclusions, the course of these cases so treated has been decidedly more satisfactory than in those treated by methods formerly employed.

REFERENCE

(1) GARDNER: Trans. Amer. Urol. Assoc., 1915.

DISCUSSION

Dr. WILLIAM F. BRAASCH, Rochester, Minn.: I believe all will agree that the treatment of cancer of the bladder is much the same as the treatment of cancer in other parts of the body; that is to say, the best results are obtained when the growth can be removed surgically. The question arises, of what value is radium in conjunction with surgical treatment? I would like to emphasize several points which we believe to be of importance. It has been our experience that if radium is used prior to surgery the operation should be performed either within a day or two following the radium treatment or a month or two should be allowed to elapse, so as to avoid the period of acute congestion and inflammation resulting from the radiation. If operation is attempted three or four days to a week after exposure to radium the tissues about the tumor may be so edematous and inflamed that it is difficult to determine the exact limits of the tumor and there may be some interference with healing following excision. When radium is applied to the surrounding tissues immediately following excision of the tumor we have on several occasions observed serious complications which we attributed to a tissue reaction from radium. If radium is used postoperatively it should be some time after the tissues at the site of excision are definitely healed.

Dr. WILLIAM E. LOWER, Cleveland: There is a general impression that we are not securing the results from surgical intervention that we should. I think everybody must admit that the reported results of surgical intervention in bladder tumors are not especially good but I think they are not entirely bad. We can only report on the surgical procedures because we have not used radium or radium emanations long enough to know what the end results will be but I believe that everyone admits the outlook is at least promising.

I reported yesterday before the American Surgical Association on end results in cancer of the bladder and I wish to give you the conclusions that I presented there; this is just a part of the paper. My personal records include 221 cases of bladder tumors of which 108 were malignant growths. Operations were performed in 81 of these with an operative mortality of 9.8 per cent. Excision was employed in 59 or 72.8 per cent of these cases, the cautery was used in 10, combined with surgery in 8, and transplantation of the ureters was performed in 4 cases, in 2 of which extirpation of the bladder was done also.

We have data regarding the length of life of 61 of the cases operated upon. Forty-one or 67.2 per cent have died, 21 or 51.2 per cent in less than one year after operation; the length of life of the remaining 18 being distributed as follows: 9, less than two years after operation; 3, between two and three years after operation; 1 within five years after operation; the length of life being unknown in the remaining five. Among 22 cases still living after operation, the length of life has been as follows: 8, less than one year; 5, between one and two years; 4, between two and three years; 1, five years and nine months; 1, six years; 1, eight years and ten months; 1, ten years; 1, eleven years. We then have living between 20 and 25 per cent of our cases and of these, 5 have been living over five years.

In carcinoma of the bladder we have records of recurrences in 18, the length of time between the operation and the first recurrence varying from one month to one and a half years with 1 case in which the first recurrence was noted after eight years. In 7 cases there was a second recurrence from one to four months after the first; in 1 case two recurrences after the first at successive intervals of three months each; and in another three recurrences after the first at intervals of two, ten and five months, respectively. This last case is still living two and one-half years after primary operation.

So, some of our best results have been in cases which we have operated for recurrence. Surgically cancer is a localized disease in the beginning and if you can cure the local growth you offer the best chance of recovery. Of course, if the tumor has become

extensive, it is impossible to make a resection wide enough to extirpate the entire growth. But a wider resection of the bladder and the transplantation of the ureter does offer a percentage of cures which is not discouraging.

Dr. Francis R. Hagner, Washington: I think that we must not forget surgery in these cases, just as Dr. Lower has said. We know very well that we get wonderful results by treatment in certain cases but there is no form of cancer that is harder to handle than cancer of the bladder. It has been my experience that the results depend on the location of the growth. Where the growth has been on the top of the bladder the patients have done well. Again the frequency of infection of the kidneys in tumors of the bladder, is a condition we lose sight of. From my own experience I think a large percentage of kidneys are infected where the growth affects the ureters. The question of transplantation of the ureter, and the subsequent infection of the kidney on the transplanted side, from the infected bladder (which is usually present) should be investigated. I believe that many of these cases have an infected kidney but do not give symptoms of this condition. After operation, if the patient dies, at autopsy we usually find advanced pyelonephritis on the side where the ureter is covered by the growth; and the interesting thing is that you lose sight of the true condition in the physical examination of the patient because the patient gives no signs referable to the kidney at all.

Dr. J. Bentley Squier, New York: I think that Dr. Bugbee should be complimented for taking a conservative view point even with radium. Dr. Hagner brought out an interesting statement and that is that carcinoma of the vault of the bladder is not apt to recur. I went over my records a year ago and reported them at the New York Academy of Medicine; and an interesting fact was that carcinoma which developed in the vault of the bladder or around the urachus where it is easy to remove and do a wide resection of the bladder, was the carcinoma which recurred most rapidly. The carcinomata which developed at

the junction of the ureter and the bladder and which were more difficult of access and in which in every instance the ureters had to be cut and reimplanted into the bladder were the ones in which I had the most brilliant results as far as recurrences go. I think this depends upon the lymphatic supply of the bladder. In the region of the urachus, is the place where there is the greatest anastomosis of lymphatics around the bladder; and as the drainage is downward toward the bladder neck, the recurrence of carcinoma where the carcinoma is situated around the urachus has been down toward the vesical neck. Recurrences in this location covers a large number of cases, but the most brilliant results which I have had, have been cases where the ureter was involved and the growth was located around the ureter, at the ureteral orifice and a large portion of the ureter had to be excised.

I believe with Dr. Braasch that the treatment of carcinoma of the bladder is no different than the treatment of carcinoma elsewhere in the body. We speak about resection of the tumor plus radium. That is an admission at the start in our own minds that we have not got beyond the tumor. And that goes back to the old idea that if you are to cure cancer of the bladder, you must get it very early and cut very wide. I can't see when you get an operable case of carcinoma and I mean a case where there is a fair chance of removing the tumor plus a large portion of the surrounding tissue, why you should use radium. I think when you use radium immediately after the operation you admit at the start that you haven't got beyond the carcinoma. Therefore that particular carcinoma was not operable.

Dr. E. L. Keyes, Jr., New York: One must take one of three positions: Dr. Bugbee's position that radium is an accessory to surgery; Dr. Squier's position that surgery will have nothing to do with radium if it can possibly do without it; and the third position which is mine, that surgery is an accessory to radium in the treatment of bladder tumors. Dr. Hagner said that carcinoma of the bladder was one of the most difficult types of carcinoma which we have to deal with. I think that carcinoma of

the prostate is much more difficult to manage. I am unable to agree with Dr. Squier that any amount of education will get these tumors to us early. The misfortune about carcinoma of internal organs is the misfortune of diabetes, that the tumor does not give symptoms soon enough.

My impression from the work I have done and the work that has been done by others at the Memorial Hospital is that there is a great future for the radiation treatment for carcinoma of the bladder. I do not know whether in the end it is going to be deep x-ray or radium. But we have seen the killing off of tumors at a distance and in spite of rather careless operation we have been singularly free from implantation carcinoma while using radium and have got a considerable number of apparent reliefs of tumors as far as cystoscopy is concerned, for a period as long as four years which is the length of time which we have been employing our present method.

Dr. J. T. GERAGHTY, Baltimore: I think that in selecting the best form of treatment for bladder tumors, it is necessary to differentiate the pathology of the different types. I do not think that anyone will advocate surgery for the benign and malignant papilloma because our experience has unquestionably demonstrated that the number of recurrences is less when the endovesical methods of treatment are employed. For all of the benign and the majority of malignant papillomata, fulguration will be sufficient. From 15 to 20 per cent of the latter variety are resistant to fulguration, and these are satisfactorily handled by a combination of radium and fulguration.

There is another group of sessile tumors which are frequently multiple and which show a tendency to recur almost as quickly as it takes to remove them. We have treated hundreds of these tumors in a single case in the course of a year. In this type of case surgery is useless, for the bladder will not have closed before the development of recurrences. Radium is the treatment for this type of tumor. It, however, will not prevent recurrence but as a rule the recurrences will respond as promptly to radiation as the original tumor.

We come then to a third group in which the tumor is infiltrating. The results to be obtained by radium in this type is not to be compared with surgery. All of the infiltrating tumors which can be removed with a clear margin should be operated upon. There is no sense in resecting, however, unless the tumor can be removed completely. Therefore, there is no such thing as a combination of surgery and radium; for operation should not be done unless the tumor can be removed with a clear margin.

There is finally a fourth group in which treatment thus far employed has yielded most discouraging results. This is a group in which the tumor has advanced so far that surgery is out of the question. It has been our experience that the surface application of radium in these cases is not sufficient and in no case in which radium has been used in this manner has a favorable result been noted. We are now implanting emanations in these tumors but what our results are it is yet too early to say.

The form of therapy to be employed will depend therefore upon the type of tumor to be treated. Radium has a field for a definite of tumor, surgery for another type, and radium combined with fulguration for another type.

Dr. H. G. BUGBEE, New York: My few remarks have brought out the discussion that I had hoped for. We all want to know where we stand in working out this difficult problem. I do not agree with Dr. Squier in that the use of radium is a confession that we have not removed the entire growth. One of my cases was that of a single papillomatous growth in the fundus of the bladder. This growth was removed with a wide surrounding area of healthy tissue. Subsequent pathological examination revealed strains of cancer cells extending along the muscle bundles below the surface of the bladder mucous membrane to the cut edge. This case, especially, led us to the employment of the radium needles after resection, as an added precaution to prevent recurrences.

As I stated in my preliminary remarks, the pathology of bladder tumors is difficult to ascertain. Dr. Geraghty has divided these cases into four different classes, but we have found that patholo-

gists have reported the same tumor as benign and malignant after removal. Certainly we feel safer to have the growth out than to have it in and rely on radium alone. Whenever it is possible to remove the growth this should be done, as in treating cancer in other parts of the body. As for the addition of radium, it does no harm when properly administered, and it may do some good.

(Slides were shown, showing method of inserting the radium needles.)

THE CHARACTER AND TREATMENT OF BLADDER ULCERS

EDWARD L. KEYES, JR.
New York

Received for publication May 20, 1922

The propositions I desire to set before you in reference to chronic inflammatory bladder ulcerations may be briefly summarized as follows:

1. Chronic inflammatory ulcerations of the bladder may be grouped into three classes, viz.: (*a*) Tuberculous ulcers; (*b*) ulcers of the so-called Hunner, or elusive type; and (*c*) incrusted ulcers.

2. The incrusted ulcer is a thing apart, apparently due to a special type of coccic infection, often located on the trigone and about the bladder neck, often clinically and cystoscopically simulating carcinoma, yet often readily curable by local applications of argyrol or of acidophilus or Bulgarian bacillus.

3. The elusive ulcer, occurring in the mobile part of the bladder away from trigone and urethra, is sometimes associated with tuberculosis, sometimes with generalized cystitis and with pyelitis. Indeed it is not yet proven that the submucous lesion is not rather the remnant of an acute generalized cystitis than a specific entity. The clinical history and the location of the ulcers suggest that they begin from mechanical causes, like a crack in a chapped lip, and are perpetuated by the incessant bladder activity set up by their own sensibility, thus making a vicious circle. The submucous infiltrate about them spreads over a wide area and over the whole of this the mucosa readily cracks on stretching. Hence the varying clinical course of the disease; hence the general tendency of the symptoms to grow worse with the lapse of years.

4. Hence also the great variety of treatments that succeed in individual cases. The mildest antiseptic irrigations relieve the symptoms of some. Immobilization of the bladder by efficient in-dwelling catheter, with or without continuous irrigation, relieves some. Indeed, resection with suprapubic postoperative drainage surely acts by immobilization when all of the infiltrated area is not cut away. Dilatation of the urethra to 30°F. has relieved two of my cases, doubtless by relieving trifling urethral retention. Cystoscopic cauterization of the ulcers by the silver nitrate pencil, by the high frequency current or by liquor hydrargyri nitratis has relieved others (treated by different men).

5. Resection does not relieve all cases, and many apparent cures by resection are vitiated by relapse. I have cured such relapse by stretching the urethra (which should be tried in every case) and cauterizing the ulcers.

6. Yet operation has a place as the last resort, to get rid of ulcers so chronically infiltrated that no other treatment will heal them. But relapse should be guarded against by careful observation and such local treatment as seems to do the most good.

7. I have no observations relating to the influence of focal infections in the etiology of bladder ulcer. The onset or accentuation of the symptoms of cystitis during or following an acute infection (notably, of late years, the so-called "influenza") is, of course, well known.

8. Tuberculous bladder irritability persisting for years after nephrectomy may be due to a variety of causes among which tuberculosis of the remaining kidney and of the urethra (causing partial retention of urine) are prominent.

9. Moreover the bladder lesion of chronic tuberculous cystitis may be a pure tuberculosis but is more often a mixed infection.

10. Discreet treatment of the bladder may, even in the presence of the tuberculosis of the prostate or of the remaining kidney, marvellously relieve the symptoms.

11. This has been accomplished in the most various ways. One may mention the administration of ol. santal; the instilla-

tions of bichlorid, iodoform in oil or carbolic acid; vesiculectomy; relief of urethral retention by the passage of the cystoscope or by the Chetwood operation; cauterization of ulcers or tuberculous granulomata by silver, acid or spark; and finally immobilization by catheter, by suprapubic drainage, by ureterostomy.

12. It would seem, however, that in certain bladders the mixed infection supercedes the tuberculosis in part or even wholly, and the lesions conform to the type of elusive ulcer. Thus Hunner informs me that he has cured two such cases by resection of isolated ulcers in the vault, the resected tissue showing no tuberculosis and I know that he has relieved a case of mine by cauterization and ureter dilatation.

13. My experience with cauterization of tuberculous bladder lesions is as follows: one case unimproved; one case (three years after nephrectomy) intervals increased from one to two or three hours, gained 18 pounds in weight; one case (five years after nephrectomy) intervals increased from incontinence to one hour; one case (seven years after nephrectomy) intervals increased from incontinence to six hours by night, four by day. The relief in this last cast has persisted one year, in the other two for six months.

14. It would seem that isolated granulomata of a purely tuberculous type have been healed by the high frequency current. I have cauterized one case (eight years after nephrectomy) once with acid but without appreciable benefit.

ELUSIVE ULCER OF THE BLADDER

A FURTHER REPORT

HERMAN L. KRETSCHMER

Chicago

In a previous paper on the surgical treatment of elusive ulcer of the bladder,[1] 5 cases were reported in which the diagnosis was verified by operation and histologic examination of specimens obtained by operation.

I now have, including the previously reported cases, the records of 14 cases. Because of the gradually increasing interest in this subject, it was thought advisable to study this larger group of cases with the idea of attempting to bring out any possible new phases of the subject and also to review the previously published cases to determine, if possible, the results of treatment with special reference to the end results.

The time that has elapsed since the first 5 cases were operated on may not be considered very long (twenty-one months in the oldest and sixteen months in the shortest), yet it seemed worth while to get in personal communication with this group of cases and to determine just what has been accomplished.

Likewise it was thought desirable to ascertain the status of the more recently operated cases with the same object in view. For this reason the patients were asked to call at the office for personal interviews and for urinary examinations. In some instances the patients lived too far away to report in person and their present status was obtained by personal correspondence. A summary of these cases is given at the end of the paper.

[1] Kretschmer, H. L., Surgical treatment of so-called elusive ulcer of the bladder, Jour. Amer. Med. Assoc., April 9, 1921.

SYNONYMS

Much credit is due to Hunner who called attention to this lesion and outlined a definite surgical procedure in the treatment of this disease, namely, wide resection of the ulcer-bearing area.

In his report he used the term "elusive ulcer," which has been somewhat confusing since those who become interested in these cases immediately begin looking for something "elusive" when as a matter of fact the ulcers are not at all elusive.

Practically every author writing on this subject has suggested a new name which only adds to the confusion and multiplication of synonyms.

Nitze, many years ago, suggested the term "cystitis parenchymatosa," but this has not met with much favor since the term has never been used.

ETIOLOGY

Up to the present time it can be stated that the cause of this lesion is unknown. Hunner suggested the possibility of a distant focus of infection as playing a rôle in the etiology, suggesting infection of teeth, tonsils, sinuses and adenoids. Bumpus and Meisser, following the work of Rosenow, conclude that elusive ulcer and other infections of the urinary organs are due to focal infections harboring streptococci, which have a selective affinity for the urinary tract.

SEX

From the very start one striking feature has been that females have been much more frequently attacked than males. Thirteen of the 14 cases to be reported in this paper occurred in women and only one in a male. Hunner's series (25 cases) all occurred in females; Bumpus reported 15 cases, 13 of which were females; Keene reported 10 cases, Reed, 5 and Fowler 3, all in women. Hunt reported 20 cases operated, 18 of which were females. The only large series of cases in males is reported by Frontz who reported 23 cases in males and only 3 in females in his series of 26 cases, his being the only report in which the males predominate.

Hunt stated that since the teeth, tonsils and sinuses are foci of infection common to both sexes, it seems that some additional etiological factor other than focal infection must explain the frequency of the lesion in the female and its rarity in the male.

MARITAL STATE AND PREGNANCY

Most of the authors are agreed that matrimony and pregnancy have no etiological bearing on this condition inasmuch as cases are seen in both the married and unmarried. Ten of the 14 cases are married and 3 have never been pregnant. These, 3 with the 2 single women makes a total of 5 who have never borne children.

Careful pelvic examinations were made without finding pelvic pathology, hence lesions of the pelvic organs can be dismissed as etiological factors and also as factors in the production of the urinary symptoms.

AGE

It would seem from the table of ages that this is essentially a disease of adult life. The youngest patient in this series is the one male, aged twenty-four. The oldest patient was sixty-one.

	Number of cases
21 to 30 years	2
31 to 40 years	6
41 to 50 years	5
51 to 60 years	0
61 to 70 years	1

PREVIOUS OPERATIONS

In no department of surgery is the value of careful preoperative study so apparent as it is in the field of urological surgery. Genito-urinary surgeons are familiar with the large number of patients with urinary symptoms who have been subjected to various abdominal and gynecological operations without obtaining relief from their symptoms. The large numbers of patients suffering from various kidney lesions, such as tone, tuberculosis and pyelitis, who have sacrificed their appendices and various

pelvic organs are evidences either of careless diagnosis or insufficient preoperative study. Cases of elusive ulcer are no exception to this statement.

Thirteen of the 14 cases gave a history of previous surgical operations. These operations can be classified into two groups. In the first group can be arranged the operations which had no connection with the bladder condition and hence have no distinct bearing on this subject. In this group we find 4 cases, 3 females and 1 male, who had the following operations: tonsillectomy (2 cases): tonsillectomy and eye operation (1 case); hemorrhoidectomy and operation for enlarged left testicle (1 case).

The remaining 9 cases had all been operated on previously for relief of their urinary symptoms, but the operations failed to relieve the bladder distress. The urinary organs had been operated on in 2 of these cases. In one case a nephrectomy was performed under the mistaken diagnosis of renal tuberculosis. This case was described in detail in the previous report on this subject.[2] The second patient was operated on and was told that a tumor of the bladder had been removed.

The remaining cases had the following gynecological and abdominal operations:

Case 1. Appendectomy, resection of ovaries and shortening of round ligaments.

Case 6. First operation, suspension of uterus; second operation, perincorrhaphy; third operation; hysterectomy; fourth operation, removal of urethral caruncle.

Case 8. Appendectomy and left ovariectomy. Hysterectomy advised just prior to coming under observation.

Case 10. First operation, appendectomy and operation for gastric ulcer; second operation, perineorrhaphy; third operation, perineorrhaphy.

Case 11. First operation, currettement and ovarian tumor removed; second operation, salpingectomy and oophorectomy.

Case 12. Ventral suspension.

Case 13. Curettage.

There was only one patient who had never been subjected to any sort of surgical operation, a female (case 2).

PATHOLOGY

All the specimens removed at operation were subjected to careful histologic examination. The microscopic picture was almost uniform. While the changes varied somewhat in extent and in minor details, the same general picture was found, as a rule, in all 8 cases. The ulcer-bearing area showed a loss of the epithelium. In several instances there appeared to be a flattening of the epithelium, so that, as the edge of the ulcer was approached, the epithelium was much flattened and formed a very thin layer. In 1 case the epithelium appeared to have changed to the flat, squamous type of cell. Some of these cells seemed to be hydropic. Occasionally the surface of the ulcer was covered with fibrin and many red blood cells were noted in some of the fibrin masses. The fibrin was not limited to the surface of the ulcer but extended beyond the edge and over and on to the mucosa. At times red blood cells were seen adhering to the surface of the ulcer.

The most extensive changes were those found in the submucosa which showed many new formed blood vessels and these were packed full of red blood cells. Round-cell infiltration was seen in the submucosa. There were areas in which the collections of round cells were very small; and in others, large masses of round cells were noted. Some of the sections showed these small, round cells closely crowded together and with the border rather sharply defined, and these areas resembled somewhat the collections of cells seen in so-called cystitis follicularis: rather dense and visible to the naked eye.

Round-cell infiltration was also seen occasionally between the muscle bundles. In several of the sections there were newly formed connective tissue cells in the submucosa, and here and there the submucosa appeared definitely edematous. In two of the sections, gland tubules were seen; and these differed in no way from the gland tubules in cases of cystitis glandularis. In one of the sections the cells forming the tubules showed secretion within the cell, so that they had the appearance of typical goblet-cells. A combination of follicle formation and gland formation was not found in the same specimen.

The changes in the muscular coat were not so extensive as the changes in the submucosa. Occasionally areas of round-cell infiltration were noted, which, however, were not extensive. In several of the sections the muscle bundles were apparently separated by edema.

A very striking change was that found at operation, the bladder wall showing an enormous thickening entirely out of proportion to the size of the ulcer. This was so well marked that in several of the cases it was possible to foretell the exact location of the ulcer or ulcers before opening the bladder.

As a rule the peritoneal coat showed decided thickening.

The specimens in 3 cases were turned over to Dr. Dick for special bacteriological examination and he attempted to grow organisms from the ulcers. The technique employed was maceration of the excised ulcer-bearing areas of the bladder. This experiment showed the presence of B. coli in case 5; streptococci in case 8 and a few colonies of Staphylococcus albus and many colonies of diphtheroid bacilli in case 9.

DURATION OF SYMPTOMS

From a review of the histories it would appear that this is essentially a chronic disease. This, however, may be more apparent than real, and the long duration of the symptoms is undoubtedly due to the fact that although the patients had consulted many physicians and had submitted to many and varied surgical operations, the long period of illness was in reality due to the fact that the condition was not recognized. In 1 patient the symptoms had been present seventeen years, during which time she had been operated upon four different times, the following operations having been performed: Suspension of the uterus, perineorrhaphy, hysterectomy, and urethral caruncle. The failure of the operative procedures is self-evident.

The shortest duration of symptoms was eleven months and occurred in the only male case in this series. A cystoscopic examination made a few days after admission to the hospital established the diagnosis and operation resulted in complete relief of his symptoms.

These 2 cases, from the two extremes of disease duration, are rather striking, showing in the one instance how easy and simple it is to straighten out these cases if the diagnosis is made at once, as against a period of suffering for seventeen years, a submitting to four surgical operations and no relief of symptoms. There does not seem to be any uniformity in the duration of the disease as can be seen from the following table:

	Number of cases
11 months	1
1 year	1
2 years	2
3 years	1
4 years	2
6 years	2
8 years	1
9 years	1
10 years	1
13 years	1
17 years	1

SYMPTOMS

Of the various symptoms mentioned by these patients, two were constant and present in each case and there were frequency of urination and pain. Both frequency and pain were the outstanding two symptoms of which the patients complained most. The pain was generally described as severe in character. The pain was of two kinds, pain that was present more or less constantly and pain that was present during or aggravated by micturition. In some instances the patients were unable definitely to localize the pain, simply stating that the pain was located in the bladder. Some were more specific and volunteered the information that the pain and soreness were located in the neck of the bladder. In 1 case the pain was so severe as to produce spasms of the bladder. In another case, in addition to the pain in the bladder, the patient complained of pain over the right hip, and in another case there was pain in the vagina. In 1 case the bladder pain radiated to the kidneys: in another, associated with the pain in the bladder, there was a constant pain over both kidneys, which may have been due to the pyelitis that

was also present. The pain was often aggravated by the local treatment to which some of the patients had been subjected prior to coming under observation.

Apart from pain in the bladder and radiating pains, there was also present pain on urination. This pain was described in such terms as burning, smarting, cutting, toothache-like and cramp-like, expressions which would lead one to suspect that the degree of pain was rather severe.

Frequency of urination was a constant symptom, having been mentioned in each and every case. The frequency was present more or less constantly, the patients never being completely free of this symptom although the degree varied. It would appear that with an apparent or temporary improvement in the local condition there was a diminution in the number of micturitions, both day and night. All these patients were obliged to arise at night, varying from once every hour to once every twenty or thirty minutes, so that they were often below par as a result of loss of sleep, as well as from the effects of the continued painful urination. In several, the frequency seemed to bear some relationship to menstruation, since there was an increase of frequency just prior to or during the menstrual period.

Hematuria. The presence of gross blood in the urine was noted in 6 of the 14 cases. This varied in severity from a slight amount of bleeding, just enough to stain the linen, to the passage of bloody urine with clots. Sometimes the bloody urine was noted only after instrumentation of the bladder, such as the passage of catheters and after bladder lavage. If during irrigation the bladder is overdistended, bleeding is easily started. This can be demonstrated very convincingly during cystoscopy if just prior to the close of the examination a little more fluid is allowed to run into the bladder so as to cause overdistension.

Other urinary symptoms were not present as constantly as the previously described group. Urgency was mentioned in 6 cases; burning on urination in 6 cases; tenesmus in 3 cases; backache in 6 cases. Gastro-intestinal symptoms were rather insignificant. Nausea and vomiting as well as rectal symptoms were absent. Constipation was present in 6 of the 14 cases and

considering that all were women, with the exception of one, this is not of any moment. Chills and fever were present only once.

Roentgen-ray examinations of the urinary tract were made in each case. No evidence of calculi was found either in the kidneys, ureters or bladder.

Wassermann reactions were negative in each case.

Guinea-pigs were inoculated and were negative for tubercle bacilli in every case.

Careful examinations of the teeth, tonsils and sinuses were made for foci of infection with the following results:

Case 1. Tonsils slightly enlarged. Teeth in good condition.

Case 2. Tonsillectomy advised. Also removal of two teeth.

Case 4. Tonsils absent. Urethral discharge and inflammation of Skene's glands.

Case 5. Asthma for twenty years. Teeth negative. Slight cloudiness in X-rays over right side. Possibly, antrum infection.

Case 6. No examination.

Case 7. X-rays of teeth negative.

Case 8. Pus expressed from tonsils. Tonsillectomy advised.

Case 9. Tonsils absent.

Case 10. No examination.

Case 11. No examination.

Case 12. No examination.

Case 13. Many infected teeth removed after coming under observation.

Case 14. Watery discharge from right antrum. Tonsils absent.

In 13 of the 14 cases accurate records of urine studies were available. In order to present the results it seemed advisable to tabulate them and they are presented below.

A review of the chart shows only one patient who had a normal urine. Seven cases had some pus in the urine. The amount was variable. Leucocyte counts made in these cases in order to have a more or less accurate record of the amount of pus present. The highest count was found in case 1, in which 7290 pus cells per cu. mm. were found. The lowest count was 70 cells.

In 7 cases the ureters were catheterized. In 2 cases pus was found on both sides, cases 2 and 14. In cases 5 and 9 the counts are a bit high in urine obtained from the right kidney.

Cultures were made with the following results: In 5 cases sterile urines were found: in 3 cases one kidney only was sterile. In the remaining cases positive cultures showed both kidneys and bladder infected with B. coli (1 case); bladder and right kidney with B. coli (1 case); colon and staphylococcus (1 case); streptococcus and staphylococcus (1 case); staphylococcus in right kidney and bladder (1 case); staphylococcus only (1 case); diphtheroids in left kidney and bladder (1 case).

The statement that the colon bacilli outgrow other organisms apparently does not hold in this group of cases. Red blood cells were found in the urine in 5 cases.

CASE	LEUCOCYTE COUNT			CULTURES			RED BLOOD CELLS
	Right	Left	Bladder	Right	Left	Bladder	
1	40	50	7,290	B. coli	B. coli	B. coli	None
2	1,420	160	1,080	Sterile	Sterile	Sterile	Few
3	6	No spec.	150	Sterile		Sterile	None
4			70			B. coli, staph.	None
5	74	34	105	B. coli	Sterile	B. coli	Positive
6			82			Not made	Few
7			Not made			Sterile	None
8			0			Strep., staph.	None
9	80	R.B.C.	Debris	Staph.	Sterile	Staph.	Positive
10				No record			
11			116			Staph.	No record
12	0	0	0	Sterile	Sterile	Sterile	Positive
13			525			Sterile	None
14	227	110	173	Sterile	Dipth.	Dipth.	None

CYSTOSCOPY

The prominent feature in this group of cases is that the cystoscopic examination was painful and the bladder capacity very limited. Cystoscopically the ulcers varied in size from a pinpoint to 2 cu. mm. in diameter. The area of ulceration was surrounded by a zone of hyperemia which was sharply circumscribed, and by the bladder mucosa which appeared normal. The surface of the ulcer may be covered with mucopus. Areas of edema around the areas of ulceration were not seen. Over distention of the bladder was the cause of pain and of starting

hemorrhage, the hemorrhage at times being so profuse as to interfere with the cystoscopic examination.

The cystoscopic picture is variable, depending on the state of healing of the ulcer. This has led to the term "elusive ulcer" (which term has been rather confusing).

In case the surface of the ulcer was healed, there was seen a definite area in which there was an increased vascularity. Most often, however, definite ulceration was seen. Many times it was necessary to carry out repeated cystoscopic examinations before making the final diagnosis. In several instances the lesion was at first confused with tuberculosis.

Location. In 9 cases the area of ulceration was seen in the apex of the bladder, that is, the dome of the bladder. In 3 cases, areas of ulceration were seen on the posterior wall only. In 2 cases the left lateral wall was the site of the ulceration and in 1 case the anterior wall was the seat of ulceration. In some of the cases there was more than one area of ulceration. In 1 case there were areas of ulceration near the right ureteral orifice in addition to ulcers in the apex.

Diagnosis. Once the condition was recognized, it was not difficult to diagnose in the subsequent cases. Because of the history of long standing distress, the extreme pain in introducing the cystoscope, which in some cases necessitated the use of anesthesia, the limited bladder capacity and the presence of areas of ulceration in the bladder, my chief concern was as regards the exclusion of tuberculosis. This was effected by diligent search for tubercle bacilli in the stained specimens as well as by repeated guinea-pig inoculations.

TREATMENT

The concensus of opinion among urologists is that this is a surgical condition and that once the diagnosis is made, nothing short of an operation will suffice. Indeed, it is the last choice as far as our therapeutic agents are concerned, since the majority of these patients have had all sorts of local treatment, the only result of which seems to be an aggravation of symptoms.

Wide resection of the ulcer-bearing area is the only treatment that has carried out in this series. Two cases were treated by fulguration. In 1 case fulguration had been instituted elsewhere and although most authors condemn this form of treatment, yet the result in this case (perhaps temporary) was rather striking.

A brief résumé of this patient's history is given below.

Mrs. M., aged thirty-eight. Symptoms started three years ago with nocturia, burning on urination, urgency and cloudy urine. Condition gradually became worse, and one year after onset of trouble patient was cystoscoped and a diagnosis of ulcers of the bladder made. Fulguration treatments were instituted, resulting in almost complete relief of symptoms. Her last treatment was six weeks before coming under our observation; came in for fulguration because of a gradual return of symptoms. Three weeks after the last fulguration she was delighted with the result and voided only twice during the night before reporting at the office. A recent letter from her physician states that she is completely relieved of her symptoms.

RESULTS OF TREATMENT

Cases operated

Case 1. Mrs. P., aged twenty-eight. Onset of symptoms nine years ago. Left nephrectomy performed for renal tuberculosis; no improvement. Complained of frequency of urination, varying from every three minutes to one hour, and of pain in bladder; hematuria. Eighteen months after resection of ulcer, patient stated, her urinary condition was very satisfactory and it was almost impossible to believe that she could get along nicely after having had so much trouble in the past ten years. Has been able to go for as long as eight hours without voiding.

Case 2. Mrs. C., aged forty-two. Trouble started four years previous to operation, with pain on urination, frequency every half hour, and nocturia from two to eight times; pyuria, hematuria; pain in back and pain in bladder during movements of the bowel. Twenty-five months after operation patient is free of all urinary symptoms. Still has pain in the back due to pyelitis. Now voids four or five times in the day and once at night. A recent examination of the urine showed a faint trace of albumin, a few pus and red blood cells. Cultures were made and showed B. coli and a cell count of 92.

Case 3. Mrs. T., aged thirty-two. Symptoms began two years ago with burning on urination, hematuria and urgency. Later pain in the bladder and frequency, every half hour in the day and seven to eight times at night. Eighteen months after operation patient says she feels she is entirely cured of her urinary trouble. Now voids every two or three hours in the day and occasionally gets up once at night. No burning or hematuria.

Case 4. Miss K. D., aged thirty-two. Symptoms present one year and complained of pain in bladder, frequency, urgency and loss of weight. Seventeen months after operation patient states she is enjoying excellent health. No urinary symptoms, but quite frequently has a feeling of soreness in left side of bladder. Otherwise thinks she is 100 per cent cured.

Case 5. Miss D., aged forty-six. Before operation complained of painful urination, frequency and nocturia. Onset four years ago. Was operated on and a growth removed from the bladder. Hematuria relieved by operation but other symptoms persisted. Fourteen months after operation for elusive ulcer patient stated she felt well until lately; at present has pain in bladder and soreness, especially on walking.

Case 7. Tony M. aged twenty-four. Symptoms started eleven months ago with painless hematuria. Two weeks later slight burning on urination and pain in perineum. Frequency many times a day and also nocturia present. Eight months after operation, cystoscopic examination showed the bladder absolutely negative. Bladder capacity 15 ounces. No pain, frequency or nocturia at present.

Case 8. Mrs. K., aged thirty-five. Onset of trouble thirteen years ago, starting with frequency of urination, burning, pyuria and fever. Later, backache, pain in bladder and vagina. Five years after onset of trouble, appendix and left ovary removed without relief of symptoms. Last October patient was operated on for elsuive ulcer; five months later stated she is feeling quite well but still has trouble holding the urine. Can hold the urine for about two hours, but after that has pain in the bladder. This condition is present day and night. Before operation, voided every hour, day and night.

Case 9. Mrs. C., aged forty-eight. Six years ago had an attack of frequency and burning on urination following a cold. Every winter since that time, patient has had similar attacks, lasting a week or more. Complained of retention, marked urgency, hematuria occasionally, backache and pain in bladder. Nine weeks after operation, patient states her frequency is much improved, voiding every two hours in the day and about three times at night. No blood in the urine since the operation, and patient can retain the urine for some time after having a desire to void. Thinks she has gained in weight. Still has a slight backache, occasionally.

Cases not operated

Case 6. Mrs. C., aged forty-nine. Symptoms started seventeen years ago after birth of her second child, at which time had pain in bladder, pain in right kidney region, pain in right inguinal region and frequency. Four operations were performed for this trouble: suspension of the uterus, perineorrhaphy, hysterectomy and removal of urethral caruncle. No treatment of any kind since coming under observation, and in the past year her condition has greatly improved; has suffered less this year than at any time in the past eighteen years.

Case 10. Mrs. C., aged fifty. Soreness at neck of bladder started about two years ago; also had frequency of urination and nocturia. Not treated; present condition not known.

Case 11. Mrs. M. Treated by fulguration.

Case 12. Miss A. aged thirty-six. Symptoms began six years ago with frequency, pain in bladder, pain and burning in epigastrium; loss of weight. Operated five years ago, ventrofixation. Symptoms not relieved; present condition not known.

Case 13. Mrs. K., aged sixty. Urinary trouble started eight years ago with frequency, smarting pain on urination and tenesmus. Many local treatments; condition at first temporarily relieved and later made worse by bladder irrigations. No treatments for two years and patient states, at present she has practically no pain and the urine is unusually clear, only occasionally cloudy. Every now and then passes pieces of tissue in the urine. Has not taken any medicine or Sitz baths, but occasionally uses a vaginal douche when the pain threatens to return.

Case 14. Mrs. S., aged thirty-nine. Symptoms have been present for ten years. Started with gradual onset of frequency, burning and pain in bladder. No treatment until 3 years ago when patient consulted a physician who told her she had inflammation of the bladder and gave her internal medicine. Has had bladder irrigations which relieved symptoms for several months; after stopping irrigations symptoms would return. Symptoms have never been very acute. In last month has had a dull pain over the right hip when lying down. Backache has been present continuously for one month.

Cystoscopy, August 16, 1921. Bladder capacity about 4 ounces. No stone or tumor seen. Near the internal urethral orifice was seen a very vascular area about the size of a split pea, in the center of which was a darker red area. No edema. Two similar lesions were seen in the apex and one on the left lateral wall. The dark area in one lesion looked like a little hemorrhage. In front of both ureteral orifices were seen edema or vesicle formation. During cystoscopy patient developed severe bladder spasm and it was then possible to demonstrate clearly the lesion in the right side.

Cystoscopy, September 28, 1921. Three or four areas of hyperemia were seen in the apex of the bladder. No real ulcerations seen. Ureteral openings were normal and catheterized without difficulty or obstruction.

Cystoscopy, January 18, 1922. Bladder negative. In the apex of the bladder were seen two areas of hyperemia the size of a fingernail. These hyperemic areas were very prominent, very well defined and apparently the site of elusive ulcers which are covered with mucosa.

Two sets of guinea-pigs were injected with the urine from the right and left kidneys and bladder on September 28, 1921 and January 18, 1922. Both sets were negative for evidences of tuberculosis. Urine was centrifuged many times and careful examinations of the sediment failed to show evidences of tuberculosis.

Patient was fulgurated on April 6, 1922, and on April 12 she stated she was more comfortable than she had been for a year. Has been voiding normally in the day and twice at night. May 1, she had a recurrence of her symptoms but not as severe as formerly.

SUMMARY

Of the 8 cases which were operated, one is having a relapse and another has pus and staphylococci in the urine.

The remaining cases consider themselves well, that is, they are free of symptoms.

Two cases were treated by fulguration with an immediate relief of symptoms. Time only will tell whether this will be permanent.

Of the remaining 4 cases, 2 are no longer under observation and the other 2 have shown an improvement in their condition, this without any treatment, However, these 2 cases are not entirely free of symptoms.

REFERENCES

Bumpus, H. C., Jr., and Meisser, J. G.: Arch. Int. Med., 1921, xxvii, 326–337.
Fowler, H. A.: Jour. Amer. Med. Assoc., November 27, 1920, lxxv, 1480.
Hunner, G. L.: Boston Med. and Surg. L., 1915, clxxii, 660; Tr. Am. Gyn. Soc., 1918.
Hunt, Verne C.: Minn. Med., December, 1921, 703.
Keene, F. E.: Ann. Surg., April, 1920, lxxi, 479.
Kretschmer, H. L.: Jour. Amer. Med. Assoc., April 9, 1921.
Reed, C. A. L.: Jour. Amer. Med. Assoc., February 1, 1919, lxxii, 332.

DISCUSSION

Dr. Frank Hinman, San Francisco: Dr. Kretschmer has brought out the question of a name for this interesting condition of the bladder. I think we are all definitely indebted to Dr. Hunner solely and individually for the definition and recognition of this condition; and I think we should honor him sufficiently to describe this condition and call it Hunner's ulcer.

I have had experience with this ulcer in 35 cases, 32 women and 3 men. And it may be interesting to mention some experimental work on rabbits in regard to the production of this ulcer. In those cases operated upon we took some of the tissue under aseptic precautions and macerated it with sand, according to the recognized technique of bacteriologists, and in each instance, even though the urine had been sterile on repeated cultural examination, we obtained an organism, in one the proteus vulgaris bacillus, in others, colon bacilli. We took these organisms and injected them into rabbits intravenously and reproduced ulcer formation or a linear type hyperemia as found in the human bladder. Bumpus and Meisser in their work on kidney infections had also reproduced bladder ulcers in rabbits.

In regard to treatment I have had the greatest success with fulguration followed by local applications with silver nitrate. In some of these cases you will find that they are definitely linear running from the posterior wall to the anterior or extending in an arched direction between the ureteral orifices. In most of these cases fulguration under an anesthetic gives immediate relief. Some are relieved so far as their pain is concerned but still continue to have some, though less, frequency. These cases have to be followed up. One fulguration does not cure, and occasionally we have fulgurated the same case as much as twelve times in two years; there are cases still under treatment, but they prefer to come for treatment every four to six months rather

than have an extensive operation. We have had some cases which have remained cured for over three years after this procedure.

Dr. Wm. A. Frontz, Baltimore: The response of these cases to the various methods of treatment will depend entirely upon the extent of the lesion. If the process is comparatively superficial and does not involve tissues beneath the mucosa, such measures as hydraulic overdistension of the bladder, the application of strong solutions of silver nitrate and fulguration will in many instances result in a permanent cure. In the lesion described by Dr. Hunner, however, the mucosa is frequently intact, the chronic inflammatory process involving the submucosa or even the muscle layers of the bladder wall. We have noted that in many of these cases where the endovesical measures were employed, there would be a temporary improvement, but in practically all cases cessation of treatment would be followed by recurrence of the former symptoms and a prompt return of the bladder to its original diminished capacity. We have come to the conclusion that if the conservative plan of treatment does not result in permanent improvement, operation should be very seriously considered. When the bladder is opened, there is no difficulty in determining the extent of the lesion. We have made it a rule after the patient is anesthetized to overdistend the bladder. As the essential lesion of this condition is a submucous fibrosis, overdistension of the bladder results in cracks and fissures in the overlying mucosa. The lesion is thus sharply outlined. If it is single and is not too extensive, resection should be carried out. If, however, the process is very extensive or if there are multiple lesions scattered at different points so that resection is not feasible, the actual cautery should be used. In one of our cases in which there was an ulcer behind the trigone and another on the lateral wall, cauterization was employed. The ulcer behind the trigone healed; the one on the lateral wall, however, did not but diminished very considerably in size so that subsequently a satisfactory resection was carried out.

So far as nomenclature is concerned, it seems to me most logical to select a term which has a pathological basis. The essential and typical lesion of this condition is a fibrosis which involves the tissues beneath the mucosa. In most instances this fibrosis is confined to the submucosa. The epithelium overlying the lesion may be intact but may be converted into an ulcer when overdistension of the bladder results in fissures in the mucosa and infection occurs. In reporting a series of these cases last year I used the term submucous fibrosis which I believe pathologically describes the condition.

Dr. R. F. O'NEIL: I should like to report briefly a case of this sort upon which I have recently operated. The patient was a women fifty-three years of age who had severe urinary symptoms for five years. Urinary frequency was marked both day and night. The urine was cloudy and contained pus and red blood cells. On cystoscopic examination the bladder was normal, with the exception of a distinctly reddened circumscribed area, a little smaller than a 10-cent piece, situated above and to the outside of the right ureter. This area bled on being touched with the ureter catheter. The symptoms were so severe that resection was decided upon. Just before operation the bladder was overdistended and on opening the bladder the area described was found to be bleeding slightly. On inspection, the area was not as well marked as I had expected to find it, nor could I feel any particular induration about it. On resecting the bladder wall, however, the tissues below it seemed considerably thicker than normal. The pathological report showed the bladder wall to be the site of chronic inflammation, but no evidences of malignancy. The case is still in the hospital and at some future time I hope to report the end result.

Dr. WILLIAM F. BRAASCH, Rochester, Minn.: That there is considerable confusion with regard to the nomenclature of such ulcers of the bladder may be observed in current medical literature. I am under the impression that many old fashioned simple ulcers and ulcers of all descriptions are often called elusive or

Hunner's ulcers which do not correspond to the description given by Dr. Hunner; and that many patients with such ulcers are incorrectly operated on. I do not see the logic in resecting the ulcer in the bladder if bacteria and pus cells are found to be coming from the kidney. In fact, I question the advisability of resection unless the urine is culture free and the ulcer definitely submucous. We must admit that the end results in the resection of submucous ulcers of the bladder have not been satisfactory. A great many patients may report relief from symptoms during a period of one or two months following operation, but the old symptoms very often return and in six months they are usually as severe as before the operation. It would be advisable to try repeated cautery with a concentrated solution of silver nitrate, or better still, fulguration, together with removal of all possible foci of infection, before resection is attempted.

Dr. Guy Hunner, Baltimore, by invitation: I agree with Dr. Kretschmer that we ought to rebaptize this ulcer. I still feel that no name has been proposed which fits the case better than elusive ulcer. I apologized for the name when I presented it in that it did not describe the widespread interstitial cystitis in the different portions of the bladder. It seems to me that to Dr. Kretschmer ought to be given the task of finding a better name. Nitze described the condition as a parenchymatous cystitis which really fits the condition very well; but, on the other hand, that does not give you the idea that there is an ulcer present. Then, the other name, the submucous ulcer does not fit. The inflammation is not only a submucous affair, it extends through all the coats of the bladder and thickens the peritoneum where it happens to be under the peritoneum. A parenchymatous cystitis describes it from the pathological standpoint more than does submucous, but the elusive ulcer describes it from the clinical standpoint. One sees these cases one week with an open ulcer and the next week one cannot find the ulcer. I have one patient I have followed for fourteen years. On many occasions I have been unable to find anything in the bladder. So it seems to me that we should retain that portion of the name, "elusive ulcer," as describing the clinical picture.

I agree with Dr. Braasch entirely. I think that some cases which are classified as belonging to this type of ulcer are simply old chronic ulcers of the bladder which will get well with local treatments. In my original paper I adhered to the differentiation that we should not find anything in the urine except of a microscopic character and that there should not be a culture in the urine if we were to classify it under this type. But I have had to change my view for I have found cases of elusive ulcer which had also a urethritis, trigonitis, and sometimes a ureteritis and a pyelitis which is secondary to the ureteritis; and in those cases, of course, we have bacteria in the urine. So I believe there are certain cases with bacteria in the urine which perhaps go with this condition. That is one reason that has strengthened my belief in the focal origin of these cases. In the past year I have seen perhaps 30 of these cases and I have not operated on any of them. It seems to me that an operation of such magnitude that gives no better results than to have 20 per cent of the patients coming back with symptoms should be discarded if we can get around the operation by fulguration or some other method that gives good results. I have some cases under local treatment who call themselves well because they are getting up only two or three times at night instead of twenty times as formerly. My results with the high frequency treatment in the early cases were not good. I did it without anesthesia, and I gave it up, but now from the splendid results that are reported I think I will try fulguration again. You can get some of these cases to go along comfortably without operation. Some of them have the visiting nurse go to their homes once or twice a week and leave in the bladder an ounce of 1 to 500 silver nitrate solution or 5 per cent carbolic solution and they get along quite nicely. I am now deferring operation until I can learn what can be done by the non-operative measures such as the above, and the use of the actual cautery and the stick silver, and especially to see what can be done by first eradicating distant foci of infection.

Dr. Bransford Lewis, St. Louis: I want to say briefly that I am glad to hear the more conservative expressions about the

treatment of these ulcer cases, which have been more here this morning. I have heard in medical societies very radical expressions that nothing will do in these cases except a complete resection. I remember in a paper read before the Southern Surgical Association in Baltimore that expression was made by a very distinguished surgeon who said it was a waste of time to use any other treatment than resection and advised operating on them immediately. I think there has been definite progress made from that very advanced and radical and, I believe, untenable position. I think that the conservative measures of dilating and fulguration and measures of that sort should always be used first before resorting to resection.

Dr. W. W. DUKE, Kansas City, Missouri: I wish to express my sincere appreciation of the honor of discussing before this society, a subject in which I have been interested for the past two years, namely, bladder disorder occurring in patients with little or no apparent pathology to account for it. I have had an opportunity of studying 5 such patients in whom I feel sure the symptoms were due to sensitiveness to certain foods.

It is well known that a relatively large proportion of individuals inherit a constitution which makes it possible for them to come sensitive to alien material and that when this is the case they react in characteristic ways whenever they come in intimate contact with the substances to which they are sensitive. An individual sensitive to a pollen, for example, may react with the symptom hay fever or asthma whenever he breathes air which contains a certain pollen. An individual sensitive to egg may have hives after eating an almost infinitesmal quantity of egg. The 5 bladder cases which I studied were sensitive to foods, in 3 cases to vegetables, and in 2 cases to grains, and whenever they ate the foods to which they were sensitive, had severe bladder disorder. The following case is cited as an example:

Case 2. A woman, aged twenty-two, was referred to me by Dr. M. T. Dingess, because of bladder trouble.

The family history was negative for allergy so far as she knew.

The past history was important only for the fact that she had been subject to urticaria at odd times in her life.

For two years before coming to me she was troubled with frequent burning urination which was at times so severe as to confine her to bed. She had been treated under many different plans without relief; in fact, she had not been free from bladder pain a single day during her illness of two years. She was treated by us for ten days with bladder sedatives without relief.

Physical examination showed poor nutrition, slight chronic pelvic inflammatory disease, cervical tear, tenderness over the bladder both on abdominal and vaginal examination, tenderness in both kidney regions, and marked evidence of ptosis.

Catheter specimen of urine showed nothing of interest except an occasional pus cell and low specific gravity. Other laboratory examinations including Wassermann reactions were negative.

X-ray examinations disclosed no stone and nothing of further interest except ptosis.

Cystoscopic examination of the bladder and urethra by Dr. J. Edward Burns showed nothing abnormal.

Intracutaneous tests showed marked sensitiveness to wheat and slight sensitiveness to several other grains (barley, rice and oats). The tests were followed after several hours by an unusually severe attack of frequent painful urination which lasted for twenty-four hours. She was given adrenalin during this attack and was told to avoid all grains, especially wheat and its derivatives. All other medication was discontinued. Two days after this she was completely free from bladder disturbance for the first time in two years.

She has continued well now for six weeks since discontinuing wheat, except for two attacks of one day each which followed the eating of wheat as a test.

Of the 5 cases with this condition which I have studied, 3 had no pathology which we could find after exhaustive examination, which would account for their bladder disorder. In 2, pathology was found but did not seem adequate to account for pain which would frequently confine the patient to bed for weeks at a time. Two of the three cases which disclosed no pathology whatever, gave a family history of allergy. Each of the 3 themselves had had other symptoms of allergy, such as angio-

neurotic edema, hives, or asthma, at some time during their life. Each of the 5 cases gave positive cutaneous tests upon intradermal injection of small amounts of substances extracted from one or more foods which they were in the habit of eating, and in each a characteristic exaggeration of bladder symptoms followed the intracutaneous or subcutaneous injection of small amounts of the extracts to which they gave positive cutaneous tests. Each of the 3 patients who showed no pathology were relieved by avoidance of foods to which they reacted, and 2 of these (in which this test was made) had a return of bladder symptoms after eating as a test, a food to which they were sensitive. The 2 patients who had pathology in the urinary tract were partly relieved by avoidance of the foods to which they reacted.

The fact that bladder pain can be caused by a food is not altogether new, especially in the lay mind. The impression has been gained however, that the pain is due to some acid or crystalloid substance, in the offending food, in spite of the fact that vinegar (an acid) does not produce such a result, nor do other foods, rich in crystalloids.

Bladder allergy differs from allergy involving the nasal and bronchial mucous membrane, gastric mucous membrane and skin, in that the bladder mucous membrane does not under ordinary conditions come in direct contact with alien substances. Bladder symptoms can occur, therefore, only after the offending substance has gained entry to the body through some distant port. Bladder symptoms are believed to occur therefore, almost always as part of a general reaction, and for this reason are more frequently accompanied by other general symptoms of allergy, such as hives and angioneurotic edema, etc., than are nasal and bronchial cases.

Furthermore, bladder symptoms rarely complicate hay fever, asthma, and other types of allergy, caused by air carried substances, such as pollen or horse dandruff, for the simple reason that in these cases, the infinitesimal amount of foreign substance in the air is rarely absorbed in sufficient quantity to give rise to generalized reactions. This makes the testing of bladder

cases more simple than the testing of respiratory cases, for the immense number of air carried bodies which can give rise to allergy rarely come into consideration.

The diagnosis of bladder allergy is not difficult if one suspects the condition. One may suspect it whenever bladder symptoms seem out of all proportion to clinical findings, especially among patients who give a family history of hay fever, asthma or hives, or who have themselves had such symptoms. The positive diagnosis of a case is a matter of discovering the offending food and of obtaining relief by avoidance of same. Intracutaneous tests are very useful for this and without their aid a correct diagnosis may be very difficult. Unfortunately bladder reactions are usually delayed reactions and may not occur for a number of hours after the ingestion of an offending food. For this reason it may be almost a hopeless matter to trace out the source of the disorder by having the patient eat or avoid certain foods.

The treatment of irritable bladders of this type may be carried out along four lines: First, removal of the cause; second, specific protein treatment; third, symptomatic treatment, and fourth, removal of coexisting diseases, should they exist, which may complicate the situation.

Removal of the cause is simple when a person is sensitive to an unusual article of food, such as tomato, onion or oat-meal. When an individual is sensitive to a common article of diet, such as milk, eggs, or wheat, which are used commonly in cooking, removal of the cause may be difficult and in this case, specific protein treatment may be justifiable.

As a symptomatic remedy, adrenalin in sufficient dosage is recommended. Patients vary markedly in their susceptability to adrenalin, so that a hard and fast dose cannot be surmised in any individual case. For this reason, it is advisable to start with 0.5 cc. or less of a 1:1000 solution subcutaneously, or intramuscularly given slowly. This can be followed at intervals of from five to ten minutes with 0.25 cc. doses until the patient experiences relief, or until the symptoms of reaction to adrenalin become more disagreeable than the bladder symptoms. This

can be repeated every four to twenty-four hours depending upon the time at which symptoms begin to return.

Dr. H. L. KRETSCHMER, Chicago: Dr. Hinman brought up the question about cultures made from the ulcers. In the specimens from which cultures were made we found various organisms; a pure culture of streptococci in one case; colon bacilli in another, and a combination of staphylococci and diplococci in still another case.

The gist of the discussion seemed to center around the nonsurgical treatment of this lesion, which I think is all right since it shows that we are striving for something less radical than extensive resection or it may, perhaps, be an indication of failure of surgical treatment. I should like to take exception to Dr. Frontz's statement about hydraulic overdistention of the bladder. In my patients we were not able to distend the bladders very much because of rather severe pain when this was attempted. You will remember the statements of Hunner and Nitze that overdistension of the bladders in these cases causes bleeding.

Answering Dr. O'Neil's question, there was a great deal of thickening of the bladder wall and of the peritoneal covering of the bladder. I agree with Dr. Braasch when he says that we should not overlook coexisting kidney infections. In most of the cases in this series, the ureters were catheterized and when coexisting renal infection was demonstrated, pelvic lavage was instituted.

I was much interested in what Dr. Duke had to say. Dr. Hunner's work has helped us to clear up many of the cases of so-called irritable bladder in women. I think that Hunner's work has greatly reduced the number of irritable bladders but there still remains a group in which the findings are negative that clearly do not fall in this group under discussion. If Dr. Duke's work will reduce this number still further, we shall be very much indebted to him.

THE TREATMENT OF PYELITIS

C. H. CHETWOOD

New York City

Received for publication August 10, 1922

To undertake to answer the question—what is the treatment of pyelitis?—is like attempting to name the treatment of cystitis. The answer in either case would resolve itself into an investigation of etiology and bacteriology. There is, however, no intention on the part of the speaker to inflict upon this seasoned assembly such unnecessary detail. The purpose is rather to speak of a single method of treatment, to report the experience therewith of those who have contributed to the subject, to give the result of a limited personal observation and to defer pending more extended observation, a qualified judgment as to its relative value.

I refer to the method introduced by Gross of Vienna involving the treatment of pyelitis by intravenous injections of neosalvarsan, with apparent strikingly successful effect. Naturally, the question arises as to what particular type of renal infection lends itself favorably to this procedure. Its value has been compared with the treatment by pelvic lavage of the same condition, the merits of which are variously estimated. The latter method has been used by some as a routine practice, often unjustified if not harmful, in any case, from one revealing a few leukocytes to that of a frankly purulent pyelitis. I garnered the opinion from some of the European clinics that lavage with the silver nitrate was applicable to colon bacillus pyelitis but not to streptococcus or staphylococcus. Be this as it may, it is interesting to note the experience of different observers with the treatment by intravenous injection of neosalvarsan.

It is stated that Porges (Necker (1)), first observed the clearing up of a urinary infection after the injection of neosalvarsan. The case was one of cystitis and pyelitis in a tabetic patient. The

bacterial coefficient in this instance is not stated but according to the same observer the treatment is without effect in gonorrheal cases.

A brief abstract of what may be gleaned from the literature is as follows: The "rationale" of the controlling influence upon bacterial invasion of the renal pelvis by intravenous injections of neosalvarsan is kindred to that of hexamethylenatetramin although *intravenous injections* of the latter do not exercise the same effect. Old salvarsan does not work. The therapeutic effect is not sufficiently explained athough it is thought in some way to be due to the splitting off of formaldehyde in the blood. Gross' theory assumed that the freeing of the formaldehyde took place in the kidney itself and his tests proved the presence of formaldehyde in the urine. Favorable results are reported in both acute and chronic cases, although in the former group the urine does not clear so quickly as in the latter.

Kall of Freiburg (2) who is attached to Professor Rost's Genito Urinary clinic, has used this method of treating pyelitis for three years. Most of the cases were post-gonorrheal but did not reveal a gonococcus infection of the pelvis. The organisms comprised B. coli and staphylococcus. The author contrasts this treatment favorably with older methods especially that of urotropin, as the former is not dependent for its success upon an acid medium. The results obtained were favorable in a high percentage of cases. In a few cases relapses occurred but improved upon return to treatment. A small percentage proved refractory to this method.

Necker (1) reports observations covering a four years' period. In summarizing his observation he states that neosalvarsan injections show beneficial effect in all cases where inflammation is limited to the mucosa of the renal pelvis and fail where the parenchyma of the kidney is notably affected. The effect is also checked if there is retention of urine either in the pelvis or the bladder.

Nathan and Reinecke reported extraordinarily favorable results and tested the remedy especially in pyelitis complicating female gonorrhea (non-gonococcus infection). Of especial interest

is this treatment in the case of solitary kidney of the nephrectomized patient.

Rencker of Herzheimer's Dermatological Clinic, Frankfurt am M. (3) embodies in his report those of Gross, Nathan and Reinecke, and Kall. He furnishes the history of 12 personal cases. Most of these were former gonorrheal subjects who had had inadequate treatment. Save for 1 case the results bore out the claims of Gross and other authors reported. There was no recurrence.

The technic is the usual method employed, namely, freshly prepared solution in recently boiled and distilled water. The average dose is 0.15 gram of the drug. Subsequent dosage according to effect and response, as low as 0.05 gram and up to 0.3 gram. Total number of doses usually four. Intervals from three to five days.

As to personal experience, I employ a 5-cc. record syringe with an unusually fine platinum, iridium needle and dissolve the dose of neosalvarsan, whether it be the minimum or maximum quantity, in that amount of water.

Case 1. November, 1921; female; age twenty-three. General health, good. Frequency of urination commenced two years ago when B. coli bacilluria was detected. Present condition: urination every two hours, day and night, painful at times but not always. Cystoscopic examination reveals general cystitis of mild degree.

Both ureters catheterized.

Right side specimen: Frequent pus cells; caudate and cuboidal epithelial cells; scattered red blood cells; microörganisms, many bacilli in chains; negative for tuberculosis.

Left side specimen: Frequent pus cells; caudate and cuboidal epithelial cells; many red blood cells; microörganisms, bacilli in chains and cocci; negative for tuberculosis.

Cultures from throat and left kidney urine yield Staphylococcus aureus and albus. Autogenous vaccine from culture administered without improvement. First intravenous injection, neosalvarsan 0.15 gram in 5 cc. distilled water. Second injection three days later. Soon afterwards blood appeared in the urine and when this subsided some improvement followed, revealed in elongation of urinary intervals from two to four hours and some clearing up of the urine. One week after second

injection a third was given of 0.1 gram. Six days after the third a fourth dose of 0.15 gram was given.

The improvement in this case was maintained for three weeks after stopping injections, then a relapsing tendency was revealed which quickly yielded to renewed treatment in a much milder dosage. At present report, three days after last treatment, intervals are about one-half as frequent as formerly and the urine in gross appearance is notably clearer. The right catheterized specimen is normally clear and the left only moderately turbid.

Case 2. March, 1922; male; aged nineteen. No venereal history. Two years ago entered hospital for alleged appendicitis. No operation. At that time blood and pus found in the urine and since then dysuria with increasing intensity. At present urination every one and one-half to two hours, day and night, with much pain before and during urination. The urine is freely purulent. Capacity of bladder reduced to between 3 and 4 ounces. Cystoscopy: marked cystitis in vicinity of trigone rendering it difficult to detect ureteral openings. Both ureters are catheterized. Right side specimen diffusely turbid; numerous pus cells, pelvic cells. Left side normal specimen of clear urine obtained. First treatment, 0.15 gram neosalvarsan injected intravenously, following which within twenty-four hours there is abatement of symptoms. Second treatment, seven days later, 0.15 gram neosalvarsan. Following second treatment, for the first time in many months patient passes the night through without the necessity of rising but once to urinate. The urine is somewhat clearer but still cloudy and purulent. Third treatment, seven days after second, same dosage.

Last report now about two weeks after third dose: bladder capacity increased to 7 ounces. Urine much clearer. Pain entirely absent. Intervals about every four hours. General health noticeably improved.

This communication is only a brief note and not a paper as it purports to be. But the subject seemed to me to be of sufficient moment to become a part of these proceedings and I hope you agree with me.

REFERENCES

(1) Necker: Rothschildspital reports, Vienna, vi, Nr. 1–2, 1921.
(2) Kall: Munch. Med. Woch., May, 1920.
(3) Rencker: Archiv. f. Dermatol. u. Syph., 1921.

GONOCOCCAL INFECTIONS OF THE KIDNEY

J. DELLINGER BARNEY

Boston, Massachusetts

Received for publication August 10, 1922

After reading the very complete article of the same title by Simmons (1) published as recently as last February, one feels as if nothing further could be added to the subject. His careful review of the literature, discussion of the routes of invasion of various organs by the gonococcus and his admirable bibliography are most valuale contributions.

It will be noted, however, that the cases reported in the literature, even when undoubted examples of infection by the gonococcus, are singularly free from any adequate description of the cystoscopic findings or of the pathology of the kidney when an operation was performed. I agree with Buerger (2) that such descriptions are lacking and that they should be made available when possible, so that the urologist may have a "well defined picture of what he is to expect when he examines the bladder in which gonorrheal invasion plays the most prominent part."

As Simmons' article does not include one additional case of gonococcal infection which has been reported, and as a case which came under my own observation is complete in all respects, including a most careful pathological examination, it has seemed worth while to call attention to these instances of the lesion under consideration.

Lehr (3) reported such a case in a man of thirty-four. There had been an attack of gonorrhea in 1903, with a second attack in 1905. There were no symptoms from then until 1911 when gonococci were found in the urethral discharge. As the urine was persistently cloudy, containing pus and gonococci, and as terminal hematuria subsequently developed, cystoscopy was done and the ureters catheterized. The bladder mucosa was uni-

formly red and inflamed but the ureters were "normal." Purulent urine, containing gonococci in pure culture was obtained from the left kidney. Treatment consisting of vaccines, and renal lavage with argyrol and silver nitrate, was continued for two or three months at the end of which time the left kidney urine was clear and free from organisms.

The following case occurred in my own practice.

V. D., male twenty-three, white, merchant marine. Admitted to the United States Marine Hospital, Chelsea, Massachusetts, April 23, 1921.

Family history. Unimportant.

Past history. Tonsillectomy and adenoidectomy in childhood. Left herniotomy in 1919.

Up to one year ago had had frequent headaches with blurring of vision. Loss of appetite for the past three months with loss of weight. No cough, dyspnea, pain in chest or night sweats. No urinary symptoms. No edema. Denies lues. Gonorrhea in April, 1920, with no complications.

Present illness. Recently acquired second attack of gonorrhea with epididymitis.

Physical examination. Well developed, poorly nourished, shows evident loss of weight.

Head, throat, chest, abdomen and extremities show nothing abnormal.

Purulent urethral discharge. Left epididymitis in an acute stage.

Smear of urethral pus shows gonococci.

Urine, twenty-four-hour amount 3000 cc. Specific gravity, 1.015; albumin; slightest possible trace; no sugar. Sediment shows an occasional red blood cell and epithelial cell, an occasional hyaline, epithelial, granular and pus-cast, together with much pus. Repeated examinations of the twenty-four hour urine were essentially as above.

Blood pressure, 144 systolic, diastolic 76.

Blood Wassermann negative.

Blood smear not abnormal.

April 25, 1921. Left epididymotomy with good recovery.

During the next few weeks patient had several attacks of severe pain in the back, lasting from five to twenty minutes, sometimes accompanied by nausea and vomiting and producing more or less collapse.

Patient referred to me on June 18, 1921. He then stated that the abdominal pain above described had begun after his first attack of

gonorrhea and previous to the second attack. The pain had been of short duration coming in severe paroxysmal attacks.

Owing to the high blood pressure, casts in the urine and loss of weight patient was thought to have nephritis, but I could not confirm this view.

Examination at this time showed a slight purulent urethral discharge, moderate induration of the left scrotum as a result of operation, a cloudy urine, and slight left costo-vertebral tenderness. Abdominal examination showed no masses or tenderness and neither kidney could be felt.

Cystoscopy on June 21 showed redness and edema involving the orifice of the left ureter and the mucosa in its vicinity, the appearances strongly suggesting a tuberculous lesion. Elsewhere the bladder was normal. Catheters passed easily to each kidney with a normal ureteric flow from each side, the amounts being about equal (a point of importance in view of the subsequent findings).

The right urine showed a few leucocytes, the left urine showed many gram negative, intracellular diplococci. Phenolsulphonephthalein (intravenous) appeared on the right side in three minutes, on the left side in two minutes (!) with 20 per cent on the right and less than 10 per cent on the left in fifteen minutes. Pyelogram on the left side showed a considerably enlarged pelvis, deformed, flattened calices and no kidney shadow. There was no evidence of stone (fig. 1).

In view of the reported presence of gonococci in the left kidney urine the bladder urine was subsequently examined on several occasions, pus and Gram-negative diplococci being constantly found. Meantime the patient ran no temperature; attacks of abdominal pain and left costo-vertebral tenderness continued as before.

Another cystoscopy was done on July 1 by Dr. Oscar F. Cox at United States Public Health Hospital No. 36, Boston, and this examination confirmed and repeated in almost every detail the findings of the first examination.

Operation was performed by me on July 7, 1921, nephrectomy being done under ether. At first no left kidney could be found but it was soon discovered lying against the posterior abdominal wall. The kidney was about the size of a pullet's egg with a much dilated, thin pelvis. The ureter was normal.

Convalescence was uneventful and the patient was discharged on the fourteenth day to continue the treatment of his gonorrhea as an out patient.

The specimen was submitted to Prof. S. B. Wolbach of the Harvard Medical School, who took great interest in the case and to whom I am deeply grateful for the following detailed report of his examination.

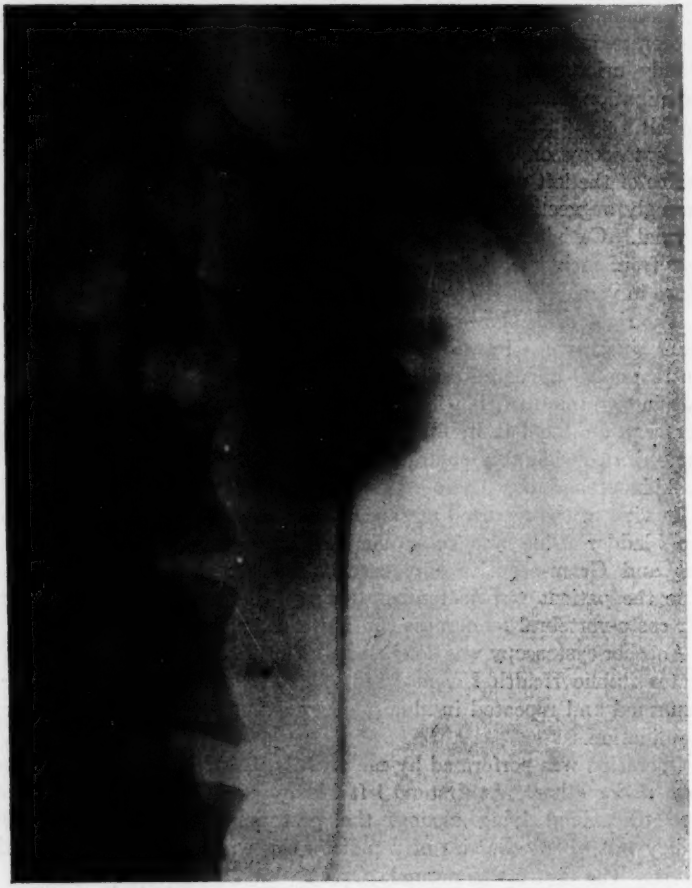


FIG. 1. PYELOGRAM OF APLASTIC KIDNEY WITH GONOCOCCAL PYELITIS

Calyces rudimentary and clubbed, pelvis somewhat dilated, no evidence of kidney shadow.

Gross description: The specimen consists of a kidney which has been opened along its convex border and about 4 cm. of ureter. The whole weighs 35 grams. The kidney is 7 cm. long by 3.5 cm. wide and 2 cm. thick. The outer surface is nodular with a distinctly thickened capsule. The cut surfaces show a dense light yellowish brown

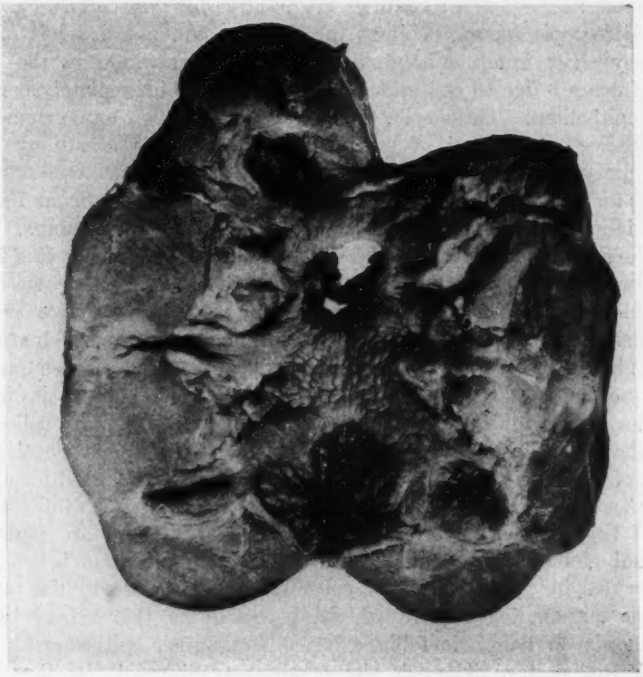


FIG. 2. INTERIOR OF KIDNEY SHOWING LESIONS OF PELVIS AS A RESULT OF GONOCOCCAL INFECTION

tissue of increased density, the dilated calices surrounded by narrow zones of fibrosis. Thus far the kidney resembles any similarly shrunken kidney. The mucosa of the calices and pelvis is striking in that it is lined with transparent, miliary sized elevations, evidently granulation tissue from which a thin, puriform material can be scraped (fig. 2).

Microscopic examination of the material from the pelvis of the kidney shows exclusively in small numbers Gram-negative, flattened diplococci within polynuclear leucocytes.

Cultures were made on two plates of blood agar.

Portions of kidney, ureter, pelvis and dilated calyces are fixed in Zenker for microscopic examination.

Bacteriological note: Cultures are positive for gonococci.

Microscopic report: Sections through the ureter and pelvis of the kidney show intact epithelium. The elevations noted in the gross specimen are due to collections of lymphoid cells immediately beneath the epithelium. These collections of lymphoid cells contain numerous capillaries and vessels of pre-capillary size. There are many large lymphocytes, some of them in mitosis. An occasional one presents a center of large cells giving the appearance of a lymphoid follicle. The lesion is very similar to that of the conjunctiva in trachoma. The epithelium covering these follicles is thinned in some places to a layer two to three deep of flattened epithelial cells. There are also occasional polymorphonuclear leucocytes in and upon the surface of the epithelium. Deeper in the submucosa are small collections of lymphoid and plasma cells, while in some of the collecting tubules are numerous polymorphonuclear leucocytes. An occasional eosinophile is found in the diffuse infiltration in the submucosa and about the collecting tubules. The histology of the mucosa and the ureter is identical to that of the pelvis of the kidney. The kidney tissue selected for study shows some radial cicatrices extending from the pelvis with intervening renal tissue essentially normal in appearance. There are perfectly normal glomeruli and tubules. A very rare diplococcus is found in leucocytes in cross sections of collecting tubules close to the pelvis.

The outstanding feature of the pathology of this kidney is the production of lymphoid follicles beneath an intact epithelium of the pelvis and ureter. There is also a moderate diffuse infiltration with lymphoid, plasma cells and eosinophiles in the tips of the pyramids. The only puriform exudate is to be found in the recesses of the pelvis and in collecting tubules.

Additional bacteriological note: The cultures made upon blood agar yielded colonies of Gram-negative, flattened diplococci which coincide in every way with gonococcus in their growth requirements. They were cultivated upon blood agar. They would not grow upon ordinary media.

From the appearance of the kidney and from the histology it seems more probable that this is a congenital aplastic kidney rather than the result of a post natal pathological process.

Diagnosis. Gonorrheal pyelitis; aplastic kidney.

Aside from the interesting and unusual nature of the infection of this kidney and the effects produced in the pelvis by the infecting organism, its aplastic condition is worthy of notice. Although such kidneys are uncommon they occur with sufficient frequency to warrant being borne in mind. Like all underdeveloped and abnormal organs they are far more likely than is the normal organ to become infected or otherwise diseased. But even when free from an acquired pathology the small amount of urine obtained from such a kidney, together with its low phthalein output, even though such findings are coupled with an otherwise normal urine, should arouse suspicion of the presence of such an organ. The pyelogram may or may not be of value for the reason that the renal pelvis itself may be within normal limits of size and shape. On the other hand the calices are apt to be small or rudimentary, and evidence of the shadow of the renal substance is generally lacking.

I take particular satisfaction in reporting this case because of the unusually complete pathological and bacteriological study. Of the 27 cases now recorded in the literature the infected kidney has been examined at operation or autopsy in only 4 or 5 instances and even in these cases adequate descriptions of the conditions are not at hand. It is also true that when operation has been done the kidney was extensively destroyed by a disease of long standing and there was also a mixed infection. My case is of value because of the presence of the gonococcus alone and also because this was of comparatively short duration, probably not more than a year, more probably only a few months.

The fact that so few gonococcus kidneys have come to operation would indicate that the infection is either so mild in its symptoms as to require little or no treatment, that it may be and generally is cured by palliative measures such as renal lavage, or that it may die out spontaneously. Operation, there-

fore, is done only in the presence of mixed infection, in which case some other organism than the gonococcus decides the issue, or in cases like my own where other factors such as hydronephrosis are responsible for the symptoms. It is therefore obvious that given an otherwise normal kidney the presence of gonococci in this kidney does not necessarily mean a bad prognosis. Collective experience would indicate that prompt, adequate, and sufficiently prolonged treatment will eventually clear up the infection. Renal lavage with either argyrol or nitrate of silver, hexamethylenamin and acid sodium phosphate in efficient dosage, and the ingestion of very large amounts of water appear to form the tripod upon which treatment must be based. It is also obvious that the infected prostate, urethra or other tissue must meantime receive appropriate attention.

REFERENCES

(1) Simmons: Jour. Urol., vii, 2.
(2) Buerger: N. Y. Med. Jour., December 14, 1918.
(3) Lehr: Jour. Amer. Med. Assoc., July 6, 1912.

REPORT OF A CASE OF OBLITERATING ARTERITIS OF THE BRANCH OF THE LEFT RENAL ARTERY SUPPLYING THE LOWER POLE OF THE KIDNEY

F. C. EDGERTON

New York

The specimen I wish to show is that of a kidney I removed by nephrectomy. It shows an advanced and peculiar stage of obliterating arteritis which has reduced the lumen to about one-third its normal dimensions—about one-half the kidney is the seat of a moderate but definite atrophy.

The following is the history of the case:

A man, forty-three years of age, barber by occupation, was admitted to Saint Francis Hospital April 15, 1917.

Previous history. Denies syphilis. No history of infectious diseases except measles when he was ten years of age. One and one-half years ago passed two small stones following a number of severe attacks of renal colic.

Present history. Symptoms began soon after the attacks of renal colic one and one-half years ago. Complains of dull pain over left kidney region, intermittently more severe, but never had a typical attack of renal colic after the passage of the two small stones. This pain has been so severe for the past month he was compelled to give up his work.

Physical examination. Negative except for tenderness on deep pressure over left kidney. Heart and lungs normal. Blood pressure normal. No mass could be felt in kidney region.

Cystoscopic examination. Bladder mucosa normal in appearance. Ureter openings normal. Functional test: 1 cc. Phenol sulphone phthaline solution injection intravenously appeared in the urine from the right kidney in about three minutes. In the urine from the left kidney in about five minutes. At the end of fifteen minutes both urines contained about the same amount excreted. X-ray picture: Both kidneys negative. Both blood Wassermann and spinal fluid Wassermann were negative. On account of the severe pain over the region of the left kidney an exploratory incision was considered advisable.

Operation, April 23, 1917. The kidney was exposed through a left lumbar incision. The fatty capsule was adherent. After separating the fatty capsule, the lower pole of the kidney appeared white and bloodless. Ureter felt normal. The branch of the renal artery running to the lower pole of the kidney felt thick and calcareous while the other vessels were apparently normal.

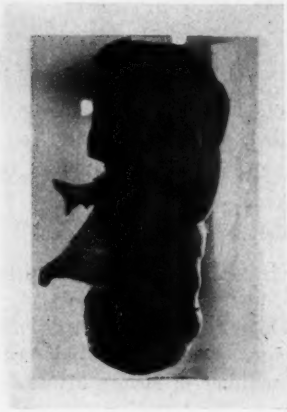


FIG. 1

FIG. 2

FIG. 1. THICKENED RENAL ARTERY ENTERS THE KIDNEY NEAR THE CENTER OF THE ATROPIC PORTION

FIG. 2. LUMEN OF THE RENAL ARTERY REDUCED TO ABOUT ONE-THIRD ITS NORMAL DIMENSION

PATHOLOGICAL REPORT

Gross appearance. About one-half the kidney is the seat of a moderate but definite atrophy, the diameter of this portion of the organ being reduced about one centimeter in all directions. The atrophic portion is otherwise not deformed. The renal artery enters the organ near the center of the atrophic portion. Over the cortical surface of the kidney there are scattered several small hyperemic areas but there is no definite area of hemorrhage, nor are they any other gross abnormalities.

Sections. Section through the normal portion of the kidney discloses marked capillary hyperemia, but no other definite alteration of structure. Section of the renal artery shows this vessel to be the seat of an advanced and peculiar stage of obliterating arteritis, which has reduced the lumen to about one-third its normal dimensions. The main lesion is in the

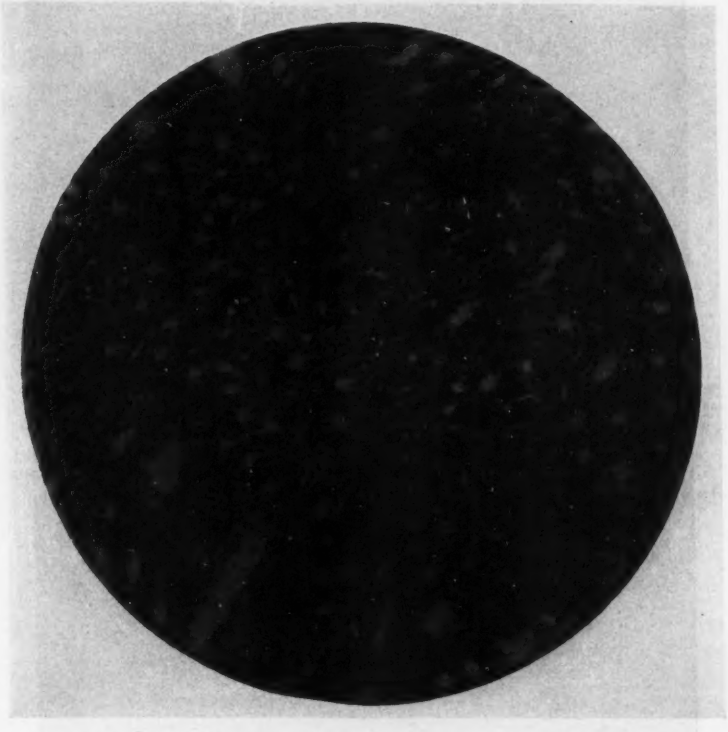


FIG. 3. SECTION THROUGH THE NORMAL PORTION OF KIDNEY SHOWS MARKED CAPILLARY HYPEREMIA

media, where the muscular tissue is replaced by old blood, hyaline material, and new cellular connective tissue. Over part of the circumference the elastic lamina is preserved, but greatly displaced inward by the blood clot, elsewhere it is entirely missing. The adventitia is distended by the blood clot but not ruptured. There is an entire

absence of the fatty changes and calcification of arteriosclerosis. Also the location of the new tissue and its character are not those of obliter-

FIG. 4. SECTION OF THE RENAL ARTERY SHOWS ADVANCED AND PECULIAR STAGE OF OBLITERATING ARTERITIS

ating endarteritis. There is a notable absence of any inflammatory process of a strictly degenerative or infectious nature. The whole picture suggests rather a lesion of traumatic origin, in which the initial factor was

FIG. 5. SECTION OF THE RENAL ARTERY SHOWS MAIN LESION IS IN THE MEDIA

Muscular tissue is replaced by old blood clot. Hyaline material and new cellular connective tissue. Over part of the circumference the elastic lamina is preserved but greatly displaced inward by the blood clot, elsewhere it is entirely missing.

a hemorrhage beneath the adventitia, followed by organization of the blood clot.

The interpretation of this lesion is difficult, but the conclusion may be suggested that in some way the presence of a pelvic calculus excited muscular spasms throughout kidney and ureter, which led to rupture of small blood vessels, the hemorrhage extending to or even originating in part in the wall of the main renal artery. In any case the absence of inflammatory changes, and the peculiar nature of the lesion does not incline one to class the process with arteriosclerosis or obliterating endarteritis, or infectious arteritis, so that a traumatic origin is the only hypothesis remaining.

DISCUSSION

Dr. JOHN R. CAULK, St. Louis: I am particularly interested in Dr. Chetwood's contribution. Pyelitis is a disease we are called upon to treat more than anything in urology. Of course, we have to discriminate between the acute and the chronic. I want to speak particularly of the acute. I am convinced that physicians temporize too much with internal medication. The uteropelvic junction is usually blocked. Whether that is fundamentally the cause of the trouble or whether it is secondarily blocked from edema, it makes no difference. At any rate the pelvis is blocked before we get symptoms from retention of pus. It is our policy to put in a ureteral catheter and drain immediately either in adults or children. It is drainage which helps, the same as in any acute infection. We must spare the kidney from retention of septic products, and the sooner one drains, the better the chance of complete recovery.

In chronic pyelitis we have to do a number of different things. It is a different story; and I have been interested in Dr. Chetwood's remarks. I have had one or two patients who were treated with neosalvarsan who had resisted other methods of treatment. I reported these cases at the St. Louis Medical Society; and in these patients the history and findings have simulated tuberculosis. Both cases I have had have been bilateral and without bacteria either culturally or by stain. One patient who had not improved on routine treatment for months, five tenths of neo, and the next day she was another girl. I gave her another one, and within a week the urine was clear and remained clear up to the present time; and I have had another case which responded in the same way. By the way, these women had negative Wassermanns and negative spinal fluids without evidences of syphilis. These may be spirillum infections.

Dr. Bransford Lewis, St. Louis: I have observed 3 very interesting cases of gonococcal infection of the kidney pelvis. One I only observed post mortem in that he came into the City Hospital service and died, never having been conscious while there, and we never got any history; but the postmortem examination developed a definite destruction of the kidney, and under cultural methods the gonococcus was proved to be present in pure culture. A second case which, so far as I know, was the first with three different urines of three different physical characteristics derived from the live human body, was that in which there were two different ureters on one side and one on the other side, and one of those two was infected with gonococcal organisms that had been the cause of the repeated recurrences for five years before the recognition of it; and three irrigation lavages, of that infected kidney resulted in permanent recovery. I reported this case in 1906 (Medical Record, October 6) and the patient got married and has had children since. That was a clean cut relief afforded on the recognition of the double ureter and the pelvic infection. A third case was also relieved, but that was not a pure culture as colon bacilli were also present.

The question comes to me, in view of the clearing up of such cases under lavages. Where does the necessity come in for removing such kidneys? I want to ask Dr. Barney to speak about that. A friend of mine told me that he had had a case of gonococcal infection and he had removed the kidney to save the life of the patient. I have never seen a case which required such radical methods; and certainly if they are not required, that fact ought to be made known to the profession.

Incidentally I want to say that I have been using the white silver of Hille who developed argyrol. It is white and makes no stain, and in that respect it has an advantage over argyrol. It is also efficient therapeutically.

Dr. Francis R. Hagner, Washington: There have been 2 cases of gonorrheal infection of the kidney in Washington. I collected 17 cases and reported before the Society years ago. Some of them were double infections. One of these cases was

cured by argyrol. In that case I got a diplococcus and it did not grow on an ordinary medium but only on blood serum media, and we felt it was a gonorrheal infection.

Dr. JAMES A. GARDNER, Buffalo: I wish to add 3 cases of gonorrheal pyelitis, 2 of which had been advised by general surgeons to have nephrectomy. We made diagnosis by culture and these cases were easily cleared up by lavage. In the third case no culture was made. Patient had temperature with pain over the right side. We found pus on the right side and considered that the condition was a gonorrheal complication. It was cleared up with silver nitrate.

Dr. H. F. HELMHOLZ, Rochester, Minn.: I have come here merely as a visitor to learn something about a subject in which I have been very much interested, namely, pyelitis in childhood. The problem is nearly as much unsolved as it was fifteen or twenty years ago. I can only say that I have enjoyed the discussion very much.

Dr. HUGH H. YOUNG, Baltimore: I would like to ask Dr. Helmholz to tell us what he does. He is at the head of an immense clinic in a children's hospital.

Dr. HELMHOLZ: That is a very difficult question to answer. Five years ago, I could have answered it at once. We alkalinize the urine and then give urotropin. I am becoming more and more convinced that if plenty of water is given and elimination is continued, the patients will get well quite as rapidly as by the giving of alkalies or urotropin. Our great difficulty is that we don't know what we are dealing with, whether with pyelitis or merely cystitis; but the tendency to healing in infancy and childhood is such that it is very difficult to learn what has been accomplished by treatment. In one case the pyelitis may clear up rapidly without any tendency to become chronic; in the next case, identical so far as we can tell from the clinical picture, the process remains for months or years. Now we do not know what

the pathologic changes in pyelitis are, and, apparently, we have little chance of knowing unless there is involvement of the kidneys and the outcome is fatal. If there is a marked involvement of the kidney in pyelitis, it will contain pus, and death will follow. But such complications are not in the majority. The usual case of pyelitis that comes to necropsy is reported normal on pathologic examination. I have been interested in this part of the subject but cannot make progress from lack of material, as the patients do not die. Only in case a patient dies from complications can I study simple pyelitis. We are, therefore, very much in the air with regard to treatment. I know less about what we accomplish by drug treatment than I did five years ago.

Dr. HUGH H. YOUNG, Baltimore: The treatment of pyelitis is indeed a very important question and I have been much interested in Dr. Chetwood's paper and particularly in Dr. Helmholtz's discussion. I have had similar experiences in that simple means have sometimes been very effective, particularly the use of very large quantities of water and occasionally I have found the use of bicarbonate of soda in large quantities for a time and then a sudden change to an acidifying treatment, viz.: benzoate of soda—10 grains three times daily before meals followed by urotropin 15 to 20 grains four times a day after meals, very beneficial. The use of water is certainly to be tried, especially in acute cases, and I have recently seen cases of acute pyelitis associated with fever and pain in which the use of very large quantities of water was the most efficacious, especially in combating the fever which disappeared completely under this treatment.

One of the most striking cases of this type was that of a man whom I saw two years ago with prostatic hypertrophy and considerable residual urine. During continuous catheter drainage he developed a fever associated with enlargement and tenderness in both kidneys and a diagnosis of double pyelitis was made. In a short time the fever became very high and the patient was irrational and extremely sick. The phthalein test was consid-

erably lowered, blood urea increased, and the patient seemed to be on the verge of death,—certainly too desperate for any surgical operation. An attempt was made to catheterize the ureters for pelvic lavage but owing to the presence of an hypertrophied middle lobe this was impossible. We, therefore, had nothing to try but internal methods and promptly instituted the water cure by every possible means—large amounts by mouth, infusion beneath the breasts, salt solution per rectum by the Murphy drip, and intravenous transfusions of salt solution. This treatment was continued as vigorously as possible. Fortunately the patient was able to take large quantities by mouth and we were frequently able to give him 8000 to 10,000 cc. a day, and in a few days the fever began to diminish rapidly, he became conscious, the phthalein improved, the blood urea diminished, the pain and tenderness in the kidneys disappeared and in the course of four weeks his condition was so good that a perineal prostatectomy was carried out under nitrous oxide anaesthesia with perfect success, and he left the hospital in the course of a few weeks well. Report a year later from his physician stated that he was still enjoying excellent health. This and other severe cases of renal infection have led me to have great confidence in the water cure, but unfortunately there are many chronic cases in which nothing can be accomplished by these means and some form of pelvic lavage is essential.

Owing to the fact that many cases are due to infectious foci in other parts of the body no permanent cure can result until these foci are removed and the attention should undoubtedly be given to discovery, if possible, the source of the infection. In a few cases, however, the infection is solely in the urinary tract and antiseptics are often effective. Nitrate of silver is, of course, a standby, but I believe it has often been used much too strong. Casper tells me that he uses it in a strength of 1:1000. We have usually employed 1 per cent, but experiments at Quinby's clinic show that very marked changes in the epithelium of the pelvis and ureter have resulted from strong solutions of nitrate of silver and that the drug penetrates very slightly. If the infection is only in the pelvis itself the reaction produced

by silver nitrate is probably of value, but the subsequent pain is often so great as to make it possible to use the treatment only infrequently. Quinby's experiments show the great value of Mercurochrome on account of its deep penetration through the kidney tubules and often as far as the renal cortex, and we have found it of value particularly as an alternate treatment to silver nitrate in 1 per cent solution. The great advantage is that it can be used daily if necessary, as there is very little reaction following its employment.

Dr. C. H. CHETWOOD, New York: My brief note is not intended to encourage loose methods but to attract attention to a simple expedient of possibly special value in a certain class of cases. The object is to aid diagnosis by checking up these cases, also to suggest its employment in the palliative care of kidney cases, similar to the management of bladder cases in place of or preliminary to operation. In my hasty review I found nothing in the American literature bearing thereupon but a great deal in European publications. In these case reports which give the clinical histories the Wassermann reaction has no particular bearing upon the subject.

Dr. J. D. BARNEY, Boston: In the published report of this case the names of all the contributors will be given, but it is interesting to know that this Society has furnished the majority of the cases, as I might mention Drs. Lewis, Hagner, Young and Lehr. So we hold the honor.

With regard to Dr. Lewis' question about operation—the reason operation was done was because of the very severe pain accompanied by temperature; also because the pyelogram showed a pretty well flattened out kidney pelvis with distended calices. As it turned out, operation was a wise thing in this aplastic kidney. But it is a fact that operation is hardly ever necessary because the cases show that those which were not operated upon were usually cleared up by lavage. Operation should be reserved for the case which has resisted all palliative treatment.

MEGALOURETER

THE IMPORTANCE OF THE URETERO-VESICAL VALVE

JOHN R. CAULK

St. Louis, Missouri

Received for publication August 10, 1922

Anomalies of the ureter have ceased to be autopsy curiosities. Since the development of Scientific Urology, they occupy a very important clinical position. The developmental errors are of three types; those of number, insertion, and caliber.

Irregularities in number are by far the most frequent. Abberations of insertion are, fortunately, the rarest, while variations in caliber hold an intermediate position and are the ones, with which we will concern ourselves in this paper. These variations have their foundation in faulty embryological development. I shall not busy you with a complete outline of the development of the urinary tract, since it is so admirably described in Huntington's Harvey Lecture, 1906, and very concisely by Bottomley in the Annals of Surgery, 1910, and by Young and others.

Since, in this paper, we are interested in the changes of caliber, let us refresh ourselves with the process of development which might have an influence on this feature alone. The first rudiment of the permanent renal system arises at the latter part of the first month of fetal life, as an outgrowth from the dorsal side of the Wolffian duct, close to its termination into the cloaca.

This bud develops in an upper direction and very promptly shows at its upper extremity a bifurcation, the forerunner of the renal pelvis. The mesodermal tissue surrounding the bifurcation and its branches, contributes to the formation of the renal parenchyma. This blastemal cap surrounding the renal pelvis is a very firm, resistant body, composed of two layers.

The ureteral bud from the Wolffian duct is, in the beginning, rather wide and narrows down to a uniform caliber by the end of the second month, at this time, wholly without musculature. At the beginning of the third month, muscle fibers appear next to the bladder, gradually extending upward, reaching the renal pelvis about the middle of the fourth month.

Constriction occurs at the point where the ureter passes over the pelvic brim. This is followed by two enlargements despite the muscle coat. The lumbar appearing during the fourth month and the pelvic, later.

The physiological constrictions at the uretero-pelvic juncture and at the bladder, also make their appearance. These three points of narrowing become more marked toward the end of fetal life as Seitz has shown, and were commonly found in the normal adult ureter by Robinson. In addition, there often occur valves, twists and tortuosities. It has been estimated that 20 per cent of cadavers of normal children have shown ureteral valves, which according to English, Duncan and Bazy are more commonly located within the bladder wall, that is the intramural ureter and play an important rôle in ureteral obstruction. The valves contain mucous membrane, submucous and muscular tissue. With this brief outline, one can see how an arrest or an imperfection of development or persistence of certain foctal structures may play an important rôle in determining the caliber of the ureter.

The most frequent type of change in ureteral caliber is enlargement. Abnormal dilatations occur with fair frequency and are usually attributable to congenital strictures or valves. Bottomley in 1910, in his article on congenital strictures, collected 56 cases. Eisendrath, in 1917, brought the number up to 67, having collected 7 others and added 4 of his own. The majority of these strictures were located near the bladder and in most instances were associated with marked enlargements of the ureters. In a few cases the strictures area was quite extensive, occasionally producing complete impermeability, the ureter being represented by a fibrous cord.

Tesseydre collected 11 such cases.

I shall not discuss the plurality of causes of ureteral enlargements. In substance, there are those secondary to obstruction and those produced by primary alterations in the ureteral wall itself. An association of the two may be expected. Whatever may be the cause of obstruction, the effects upon the ureter are the same, and consist almost invariably in the production of a thin-walled tortuous tube varying in caliber from that of a pencil to that of the small intestine showing kinks, windings, and twists. The wall of such ureters often exhibits valvelike folds, which according to Hamann represent the fetal type. In only 3 of Bottomley's collected cases, was the ureteral wall mentioned as being thickened.

The enlargements due to changes occurring primarily in the ureteral wall may be congenital or acquired—of these we hear but little. The changes in the ureteral wall from inflammatory conditions are familiar and aside from tuberculosis, seldom are they sufficient to cause caliber changes of much magnitude, the most constant observation being irregularity in outline. I am unable to find a description of an enlarged ureter incident to a primary congenital defect in the wall of the duct itself. Such a condition must be possible as it occurs in other structures of a somewhat similar physiology and anatomy.

EFFECTS UPON THE KIDNEY

In looking through the surgical literature and in consulting pathological and anatomical reports, I find that wherever there has been a dilatation of the ureter, there has usually been an associated dilatation of the renal pelvis. Indeed, the effect upon the renal pelvis has always been the more striking, ranging from a moderate retention to enormous sacs, completely destroying the parenchyma. Primary atrophy has occasionally been reported although recent experimental study does not bear this out. I can find no citation of an enormous dilatation of the ureter without either dilatation or atrophy of the kidney. If the ureteral dilatation be coincident to a partial obstruction, whether this be stricture or valve, the chances are that the pelvis of the kidney will suffer dilatation with the ureter. It is, however, possible

that compensatory hypertrophy and dilatation of the ureter might be sufficient to protect the kidney pelvis against back pressure dilatation and may offer an explanation of the origin of the condition about to be cited.

Clinically, up until the time of Eisendrath's report in 1917, there had been very little surgical literature on the subject of congenital obstruction and dilatations of the ureter. Such hydroureters with their associated hydronephrosis are usually incompatible with life and most of the individuals die in infancy. A few, according to Bottomley die in old age; very seldom is the condition observed in middle life.

I wish to bring to your attention a condition of the ureter and submit to you the history and findings of a patient in whom it has been observed. Namely, an enormous dilatation of the ureter without demonstrable obstruction at the lower end without a corresponding enlargement of the renal pelvis and without changes of renal function, commensurate with such a degree of ureteral dilatation. I am inclined to believe that the ureteral enlargement represents a defect in the ureteral wall itself—in all probability of a congenital nature and comparable to the condition in the large bowel, particularly the sigmoid, which is known as giant colon, or Hirschsprung's disease. Entertaining this belief, I present it to you under the name of megaloureter.

Mrs. B. St. Louis; aged thirty-two; married. Seen first in January, 1920. Complaining of frequent, urgent urination and pain in the bladder when it is full.

Family history. There are no congenital abnormalities as far as patient knows in any of her parents, but patient has a child with a cleft palate and harelip.

She had suffered from profuse uterine hemorrhages for three years. The periods would last from ten days to two weeks, bleeding profuse, containing numerous clots. She had been curetted several times, without relief. She has had two children, one with harelip and cleft palate. There was one miscarriage about one and a half years ago. Severely torn with first child but repaired with good result. Had no fever or chills, or signs of kidney obstruction during pregnancy,

but during the full period of gestation had an irritable bladder which was relieved after delivery. Has never had tonsillitis, but has repeated colds.

One year before admission, had her appendix removed. Three weeks before removal of appendix had persistent pain in lower abdomen and frequent, painful, urgent urination. Pain in abdomen was on left side, reflecting over to the right. Associated with this pain, there was an ache in the left kidney region. One tube and ovary were removed with the appendix. The appendix was tuberculous. She was relieved of the pain over the bladder after the operation, but has always had frequency of urination, amounting to every hour, day and night during the last year. Within the last few months, she has had pain in the lower left back of a dull aching character.

She has passed no blood. Has had occasional chills and fever. No sweats. There has been no loss in weight, but patient has been so fatigued and exhausted that she has been confined to her bed most of the time.

Examination. A well nourished young woman. Mucous membrane somewhat pale. Examination of heart, negative. Lungs show chronic bronchitis, no tuberculosis. Abdomen flabby, and except for tenderness along the lower left quadrant is negative. Reflexes normal. Neither kidney palpable nor tender.

Cystoscopy. Cystoscope passed and formed very cloudy urine which showed upon analysis, specific gravity 1.016, albumin, no sugar. Microscopically pus and a mixed infection of staphylococci and colon bacilli. Bladder capacity 250 cc. Internal orifice somewhat irregular there being villous proliferations in the lower margin. Trigone hypertrophic and irregular with bullous edema running along the interureteric bar and the left margin of the trigone. No ulcer, stone or tumor in bladder. Ureteral orifices perfectly normal in appearance. Both catheters passed easily without obstruction. Urine from left side showed pus, colon bacilli and staphylococci. Right side normal. We were unable to find any tubercle bacilli from the left and guinea-pigs were inocculated several times, and always gave negative results.

A functional test with phthalein appeared in eight minutes on the left after intravenous and four minutes on the right. In twenty minutes 7.5 per cent on the left and 19 per cent on the right. Considerable retention noted from the left side. I took it that we were dealing with a left hydronephrosis which had interfered with the function capacity of this kidney. X-rays were negative for stone, but

FIG. 1. SHGWING ENORMOUS DILATATION OF RIGHT URETER

FIG. 2. NO DILATATION OF RENAL PELVIS

there is seen along the left side, a broad tape like shadow which corresponds to the location of the ureter. Ureter catheterized a week later and 8 ounces of urine were drained from the left side. Specimen still contained pus, colon and staphylococci.

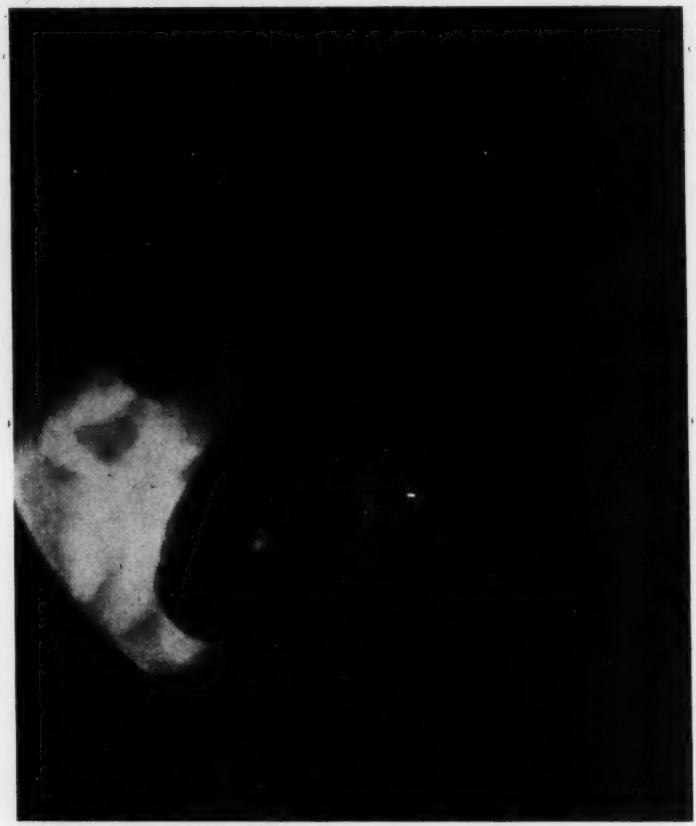


FIG. 3. TORTUOUS DILATED UPPER URETER; PELVIS NORMAL

Patient was then x-rayed with catheters in place and it was found that the catheter was curled upon itself down in the ureter, reaching not quite to the promontory of the sacrum. The ureterogram was then done and after putting in 9 ounces of sodium bromide, the

pictures, as you see in figures 1 and 3 were obtained. Namely, an enormous dilatation of the ureter, particularly pronounced in the pelvic spindle, being at least 1½ inches in diameter and running directly upward with very slight tortuosity to the kidney pelvis.

FIG. 4. DILATED, TORTUOUS RIGHT URETER; CATHETERS CURLED UP IN THE LEFT

The upper part of the ureter shows a straight, smooth line along its inner margin with practically no irregularities. This smooth symmetrical dilatation runs directly to the pelvis of the kidney, which

preserves its normal conformity below, but at its upper margin shows a slight rounding. The true pelvis is slightly broader than it should be, but the calyces themselves are sharp and pointed and show not the slightest evidence of hydronephrosis. That is, signs of obstruction. In other words, there is an enormous dilatation of the ureter without dilatation of the calyces and only slight dilatation of the upper part of the true pelvis.

Pyelogram taken of the right kidney shows practically a normal pelvis and an undilated ureter.

At another time, after removing the retention from this ureter, a functional test was done and the function of the two sides compared, the right now puts out 24 per cent in thirty minutes and the left 32 per cent. It was evident that the previous low function of the left side was due to the fact that we did not get all the urine from the ureter. Another ureterogram was then done which showed the same dilataton of the ureter, starting bluntly at the juxta vesical ureter. I thought it was due to a congenital valve within the bladder wall since I was able to pass two catheters with ease through the ureteral orifice and a large Carceau went in without the slightest obstruction. This, of course, eliminated stricture, but not valve. I drained the left ureter repeatedly, every two or three days and washed it with various antiseptics, but was never able to relieve the patient of the infection or of her symptoms of malaise and intermittent fever. She would feel better after emptying the ureter of its contents, which was always from 6 to 9 ounces.

Repeated functional tests showed that the left kidney was better than the right. Sometimes they were both low and sometimes they were good, depending upon the amount of absorption the patient was getting. In other words, we were dealing with an infected retention in the left ureter with the kidney possessing excellent function, even better, as a general rule than the function of the other side, although the function of the other side was frequently normal and the urine always uninfected.

Showing no improvement under repeated drainage, something more radical had to be undertaken. My first impression was that the kidney would have to be removed since ureteral transplantation into the bladder with such a large flabby infected ureter would in all probability be inadvisable.

On two occasions, I slit the orifice with the scissors designed for the Brown Burger cystoscope. And with a small incision, as one is able

to make with this instrument, the patient showed some improvement and was able to empty the ureter at times down to 2 to 4 ounces. There was recontraction, however, and the condition assumed its previous relations. Because of this improvement from a slight incision of the uretero-vesical valve, I proposed to the patient that we make a much more extensive incision under an anesthetic. Under a whiff of gas, I passed a rather large pair of eye scissors, made especially with a long handle, by the side of the cystoscope and the ureteral orifice was cut for about $\frac{3}{8}$ inch through the scar tissue of the previous cuttings. The edges of this incision were quite rigid and we cut them away, leaving a gutter. Following this, there was a sudden gush of urine which clouded the field. Two no. 6 ureter catheters were then passed into the ureter and left in. An interesting thing is, that almost immediately after the patient was awake and the kidney began to secrete, there was intermittent, snappy secretion from this kidney. In other words, the ureter had its normal peristalsis.

There was no immediate trouble following the operation, but the patient had a great deal of bladder irritability for about two months. The symptoms were really out of proportion to the findings.

She was in Chicago and I advised her to see Dr. Kretschmer. This she did and Dr. Kretschmer's findings were as follows:

"Patient's left kidney function at the time was much better than the right. Infection in the left side, not in the right. A very large ureter, the size of a small gut with no dilatation of the renal pelvis. She had, at this time, a very stormy bladder." Dr. Kretschmer's opinion was, that the patient was in a state of semi-invalidism and had evidently received but little benefit from non-operative treatment and he felt that either a nephro-ureterectomy or an anastomosis would be necessary, most probably the former.

I saw the patient about two weeks after this and she was beginning to improve. At this time, her urine was perfectly clear and there was no retention in the ureter. There was still marked reaction around the left ureteral orifice. She gradually improved in strength and health. Bladder irritability showed a remarkable change and except for occasional flurries, gave her no discomfort. I have watched her at least every week since then. Have catheterized her left ureter repeatedly and, with one or two exceptions, when one ounce was found, there was no retention whatever. She has had repeated colds, and almost invariably following colds gets a recurrent infection in the ureter. This is usually evanescent.

Cystoscope has shown, since September, that the ureteral orifice is open and gaping and one is able to put a Garceau catheter and two other catheters in this opening.

A recent ureterographic study has disclosed some interesting phenomena. In spite of the fact that she has emptied her ureter for eight months, I can, at the present time, put 8 to 10 ounces of fluid in it without causing her pain and there is still an enormous dilatation. I was convinced that this would be so. I have studied the emptying process of this ureter by repeated radiographic examinations and tried to determine the manner in which it is excreted. After filling the ureter, plates were taken throughout its extent at different intervals.

At the end of five minutes, it is noted that the true pelvis is still completely filled, but the calyces contain practically nothing. The outline of the pelvis appears normal and tapers down to a normal point at the uretero-pelvic juncture in striking contrast to the picture taken when the ureter was full, in which case the whole upper ureter was broad. This, I take it to represent forcible muscle contraction of the upper ureter, wherby the ureteral walls approximate in the region of the upper normal physiological constriction. This would seem to indicate the preservation of great tonicity of the internal circular coat in the upper ureter. This may be the safety valve which has protected the pelvis against dilatation. It is in this region, where the peristalic waves have their greatest metabolic rate.

There is seen no fluid in the upper ureteral spindle, figure 4, but the lower ureter is still large and contains a great deal of fluid and shows an interesting condition at its lower end. One can see a fine line of fluid running from the ureter into the bladder. This line is less than $\frac{1}{8}$ inch in diameter and about the same length. It is possibly the remains of the intramural ureter. There is a certain amount of the material seen in the bladder at this time (plate 6), and the lower end of the ureter instead of being rounded, is angular, evidently from muscle effort.

At the end of fifteen minutes, after patient had been up and about, there is seen more bromide solution in the upper ureter than at the end of five minutes, yet none in the calyces of the kidney and the uretero-pelvic juncture does not come to a point, but the upper ureter is broad throughout and reaches almost to the fourth lumbar transverse process. There seems to be less in the lower ureter than at the end of five minutes, but no line of communication between these two, the mid-ureter is still empty (plates 1 and 4).

The explanation of this can be that there has been either a peristalsis, or a regurgitation from the ureter itself or from the bladder directly to the kidney pelvis. On filling the baldder, under great pressure, there is seen some material in the lower ureter, but none in the kidney pelvis.

Reversed peristalsis in the ureter has always been doubted, but we have seen calculi rapidly driven from the upper to the lower ureter, and since this patient was up and about, the picture taken in the semi-upright position, eliminating dependency, from the fact that there was no material in the pelvis after over filling the bladder, would seem to indicate that this process of secondary filling of the pelvis is in all probability due to a regurgitation in the ureter itself or possibly to retro-peristalsis. The lower ureter is still enormously distended up to the middle of the sacrum, at this location the upper part comes together at a point, again showing muscle contraction. At the end of one hour, there is still retention in the lower ureter.

We see, therefore, that this ureter, released of some of its tension at the vesical orifice, is able to keep itself empty under ordinary conditions. Yet when it is suddenly filled, its outline is the same as before the cutting of the orifice and it requires considerable time for the complete evacuation of its contents.

This patient was seen three days after this study was made and the ureter was entirely empty and urine was being ejaculated intermittently through the catheter. The renal function at this time showed 25 per cent from the left and 20 per cent from the right in thirty minutes.

The points of interest are: Enormously dilatated ureters without a corresponding dilatation of the renal pelvis—without evidence of a lower ureteral obstruction, except the possibility of a small intramural valve and without proportionate disturbances of renal function.

Marked improvement followed an extensive cystoscopic incision of the uretero-vesical valve.

Since Braasch and Draper showed that the uretero-vesical orifice could be incised without deleterous effects, this procedure

has been employed for stricture and stones at the orifice. I have also found it valuable for stones in the lower ureter. On several occasions, I have had stones remain stationary for a long time in the lower end of the ureter well up from the bladder and showed no tendency to pass after intraureteral manipulation, to be promptly extruded after the incision of the orifice.

I believe the extensive incision of this valve for over a centimeter has worked an extraordinary benefit to the ureteral condition, described in this paper. There was regurgitation up this ureter following marked intravesical pressure. This condition had not been present previously.

Another very interesting feature was the persistence of peristalsis often such a protracted dilatation. A point of great interest was the refilling of the upper ureter after it had been empty, with the plate taken of the patient in an upright position in order to eliminate dependency. This may represent retroperistalsis or it may be a regurgitation from the ureter or bladder to the pelvis, but with the amount of pressure necessary to force the fluid into the ureter from the bladder and the pain and discomfort produced to the patient in so doing, speaks rather against this and for a reversal of the ureteral current.

There was found no sign of nerve lesion to explain its genesis. As a matter of fact, large ureteral dilatations are not proportionately common in diseases of the central nervous system.

Patient gave birth to a child with harelip. As you are well aware, embryological arrests in development are not uncommon. For example, harelip seems to be due to temporary arrest of a single process during the early part of the second month, followed by a wholly normal subsequent development.

Coloboma is a result of a similar series of events occurring at the same time. It seems quite possible that this type of ureter may belong to the category of temporary early arrests. If the ureter were to remain larger than normal until its muscular coats were formed, it would probably continue in the same relative proportion.

Another possibility is that the disturbances may have occurred in the fourth month at the time when the ureter normally forms

enlargements. It may be also that there is sufficient musculature, particularly in the upper ureter to protect the renal pelvis against back pressure and the fact that the early pelvic bifurcation is surrounded by the blastimal cap may also have had a protective influence. On the other hand, it may be that there has been a persistence of the valves in the intramural part of the ureter.

The ureteral condition discussed in this paper impresses me as having a marked similarity to giant colon. You will remember that the origin of this condition of the bowel has created considerable discussion and at the present time has not a satisfactory explanation.

The three chief theories as to its genesis are, first, congenital defect in the development of the bowel itself; second, that it is due to some form of mechanical obstruction and that the colon dilatates in an effort to overcome this obstruction; third, that it is due to spasm of the circular muscles in the lower part of the intestine and the dilatation of the colon follows this spasm, just as dilatation of the esophagus follows cardio spasm.

Dr. Will Mayo, Dr. Finney and Dr. Dowd have contributed important articles on this subject. In discussing this subject with Dr. Walter Mills, he inclines to the belief that the normal recto-sigmoid sphincter exerts obstructive influence on the bowel, which is not possessed of its normal tonicity due in all probability to some condition of the bowel itself. It is a condition of the large bowel seldom going beyond the ileo-cecal valve. This coincides somewhat with my opinion as to the ureteral condition. That the wall of the ureter itself was probably, by birth, enormously enlarged with musculature, that is incompetent to empty this ureter, against what would be a normal physiological resistance at the uretero-vesical valve. It may be that the ureteropelvic orifice has a protective influence on the renal pelvis. At any rate, the pelvis has been completely spared.

The peculiar emptying of this ureter, in really a convulsive way, is also similar to the emptying of a giant colon. It is possible that there is an incoördination between the muscle of the ureteral wall and its sphincter and that the discordant waves of the ureter undergo fibrillation, finally to break with a heavy expulsion.

Finally the treatment offers a serious problem. Dilatations are entirely ineffective. Uretero-vesical anastomosis would in all probability be unsuccessful. Uretero-intestinal anastomosis would be out of the question and one would have to remove a kidney so normal as this. For this reason, if the simple method of incision of the uretero-vesical orifice is effective, we are very fortunate. In the female, it can be done effectively by special scissors put beside the cystoscope, but in the male, such a free incision with the delicate instruments for an operating cystoscope would be hard to perform.

DISCUSSION

Dr. WILLIAM C. QUINBY, Boston: Since Dr. Caulk has thrown down the gauntlet, I must answer. I agree with him in the treatment but I disagree with him in the etiology. There seems no reason for his assumption regarding a condition which we can explain better in some other way, namely, as of congenital origin. One finds in the autopsy protocols of babies an occasional case where there is a dilatation of the ureters, the cause of that dilatation, in the absence of infection, being due to stricture formation at the interstitial portion of the ureter just as it enters the bladder or just outside of the bladder wall in the terminal portion of the ureter itself. A photograph of such a condition as this I showed before this Society last year. The reason I feel so strongly about this matter is this, that in two instances it has been my fortune to see this exact condition develop under my own eyes while the patient was in the hospital. If you will pardon the repetition, I can mention the case reported last year of the patient who had this type of ureteral dilatation developing as a sequel of a meningitis from which she was unconscious for a number of days. There then developed urinary infection with subsequent dilatation such as Dr. Caulk has referred to. And also in a second case dilatation occurred which followed a much longer standing infection in a girl who had severe intestinal difficulty as the point of origin. So I still feel, in spite of Dr. Caulk's brilliant paper, that such dilatations of the ureter are the result of a combination of obstruction and infection. They can be caused by either or both.

Dr. HUGH H. YOUNG, Baltimore: I had a case almost identical with that of Dr. Caulk. The patient was a woman about thirty-five years of age (B. U. I., no. 5168) with no history of venereal disease nor urinary trouble, until 10 years before when she began to have burning on urination which came on in intermittent

attacks lasting one or two days. Five years ago she first began to void at night. The burning and frequency of urination gradually increased in severity and the urine became purulent. She has never passed a calculus but in recent years has had a dull pain in the right side, which is still present, and she still suffers from marked frequency of urination in the day and burning on micturition. There was apparently never any difficulty of urination.

At cystoscopic examination nothing definite was made out except a chronic cystitis. There was no valve or bar at the vesical orifice, ureteral orifices were not enlarged and these were catheterized and we found them markedly dilated with purulent urine and bacilli on both sides. X-ray showed an enormous dilatation of the ureter on each side, as shown in the accompanying radiograph in which dilatation of the calyces, pelves and ureters are seen on both sides. Phthalein appearance time was 5 minutes, elimination in two hours 10 per cent, blood urea 1.16 grams per liter.

A suprapubic operation was done with the idea of relieving the back pressure upon the kidneys. Inspection of the bladder showed no trabeculation, pouches, cellules nor diverticula; ureteral orifices were pin head in character and when pressure was made with retractors on the posterior wall of the bladder a steady stream of urine came out from each ureteral orifice, showing considerable dilatation of the ureters with fluid but no tight stricture. Ureteral orifices seemed a little higher than normal, posterior portion of the margin apparently a little elevated and the muscle a little thicker than normal, but the orifice was easily dilatable and there was apparently no contracture of the orifice nor valve present. A small sound was passed without difficulty into each ureter without meeting any stricture or valve, but at a point about 1 cm. above the orifice a muscular region was present which seemed definitely thicker than the normal bladder muscle, but even this was easily dilated with successively increasing sounds. The terminal portion of the ureter was then divided along the anterior surface with a probe opened bistoury and the orifice enlarged until the finger

could be easily introduced into the greatly dilated ureter. Inspection showed no valve nor post-vesical pouch nor point of obstruction above the bladder. The object of these procedures was to completely relieve the ureter and kidney of back pressure with the hope that there may be a restoration of function. Eleven days after operation the blood urea had dropped to 0.66 gram per liter, but unfortunately the patient developed pleurisy and thrombo-phlebitis of the left femoral and iliac veins and died seven weeks after the operation. An autopsy was not obtained.

I have given this case in detail because the subject is one of great interest and cases in the literature are of great rarity.

Dr. WILLIAM F. BRAASCH, Rochester, Minn.: I have seen several cases of marked dilatation of the ureter extending from the dilated orifice to the renal pelvis in which no stricture was demonstrable, with absolutely no evidence of obstruction in the bladder or urethra. Although the ureter may be greatly dilated, it is not uncommon to find the pelvis of the kidney quite normal. It is difficult to explain how such a kidney can protect itself from infection. It may be that the peristalsis in the upper part of the ureter is sufficient to protect it.

We have recently observed a patient with a ureter of this description, who complained of severe attacks of pain referred to the right upper abdomen. It was thought at first that the pain was caused by the factors which caused the ureteral dilatation, but the patient also had definite symptoms of gallbladder disease and we decided to make an exploration through an anterior incision. The gallbladder was found to be full of stones and diseased; the ureter was explored and nothing found to account for the dilatation. This patient was dismissed from the Clinic six months ago and reports that he is entirely free from pain. I believe that some disease of innervation of the ureter causes this dilatation.

Dr. CAULK: Was that ureter thickened that you palpated? I tried to do it with pneumoperitoneum.

Dr. BRAASCH: The ureter was described at operation as thickened and dilated.

Dr. JOHN R. CAULK, St. Louis: I thought at first that I was dealing with a stricture but there was no stricture in this case. The points that impressed me were the enormous ureter without pelvic dilatation and with good function and with the convulsive, powerful peristalsis. I felt that there was something a little different. As to fulguration, I might try it.

A CASE OF SACRAL KIDNEY

ARTHUR L. CHUTE

Boston, Massachusetts

Received for publication August 10, 1922

In July, 1916, a married nullipara, twenty-seven years of age, came to me because for three weeks she had had a frequency that was so constant and urgent as to constitute almost an incontinence. She had always been well except that when she was twelve years old she was "run down" for a while, and six months before I saw her, she had had an attack of acute abdominal pain that lasted three hours and required morphia. It was thought at the time that the attack might be of renal origin but no examination of the urine was made. Examination at the time that she came to me showed that her bladder had the appearance of a resolving cystitis. The urine showed a few organisms of undetermined nature and a little pus. A series of x-rays were negative except that it was thought that the left kidney descended nearly to the crest of the ilium. The patient was sent into a hospital for study.

A radiographic catheter was passed up this patient's left ureter, as she had begun to refer her discomfort rather more to that side; this catheter went in an ordinary distance. There was little, if any, residual in her kidney pelvis; the urine from that side was not quite transparent and contained leucocytes, cocci, and a little accidental blood. The kidney pelvis was filled with 5 or 6 cc. of thorium and radiographs of the renal region were taken; when developed these plates showed neither catheter nor thorium. The next day we went through the same performance. The third day we tested our radiographic catheters and thorium and found they cast perfectly satisfactory shadows; we put a catheter in the right ureter as well as the left on this occasion; both went in about the same distance. The fluoroscope showed

that the right ureter catheter went up into the loin, while that on the left went no further than the brim of the pelvis. Plates bore out this observation. Thorium that was put into the left catheter showed itself in the region of the sacrum; there were patches that seemed to indicate the pelvis of an abnormal kidney. Stereoscopic plates showed that the ureter catheter after entering the ureter went back sharply, then came forward and looped up to about the top of the sacrum. The diagnosis of sacral kidney seemed perfectly evident. On pelvic examination I thought I could feel a mass over the sacrum and to the left side of the pelvis.

This patient, who was told that I thought she was safe enough unless she became pregnant, decided to postpone operation for a time. Six months later she returned saying that for the preceding three weeks she had had considerable pain and was ready for operation. An incision was carried through the fibers of the left rectus muscle from the level of about the umbilicus down; its lower end was curved in and ended in the median line about two finger breadths above the pubes. The peritoneum was displaced inward, uncovering the kidney which was just to the left of the center line; it had a lobulated appearance. The upper portion overlapped the brim of the pelvis and was almost at a right angle to the lower part which was on the front of the sacrum; the lower pole was fixed in the depths of the pelvis. The ureter and pelvis arose from the anterior surface of the mass. The ureter which seemed to be rather short in spite of its appearance in the radiograph was tied and cut. The chief blood supply appeared to come from the aorta; it was perhaps $1\frac{1}{2}$ inches long and divided so that one vessel ran in a sulcus on either side of the lobe, to which I have referred as extending over the brim of the pelvis. These vessels entered the kidney pelvis at the hilum on either side of the ureter; as the kidney had not rotated the hilum was on its anterior surface. This main branch from the aorta was tied and cut. On separating the kidney on the left I came across a dense band which proved to be an artery from the left internal iliac that entered the kidney on the left side, behind and below, on the surface opposite from that where the pelvis was situated. This was ligated as

was also a third vessel that arose from the sacralis media and entered the kidney on its anterior surface on the right and below. The incision was closed in layers with a rubber wick extending down to the depths of the wound. As there was a question of a small hole in the bladder a retention catheter was used. This patient made an uneventful convalescence and was last seen three and one-half years later, at which time she had had no recurrence of her urinary symptoms.

The difficulty that I had in recognizing this anomaly by radiography, simply because we were not thinking of the possibility, shows how in all renal cases we must bear in mind the fact that anomalies of position and contour are always possible, and that we must be awake to that possibility. That was, of course, less well understood six years ago, at the time this case was seen than it is today.

The reason that I advised operation in this woman's case was not because she had had severe pain, not because she had a mildly infected kidney pelvis, but because of the danger that I felt pregnancy, a reasonable probability in her case, would bring to her. It seemed to me that a fixed mass as large as this kidney would more than likely offer a considerable obstruction to labor, and that labor on the other hand would offer a considerable probability of severe damage to the friable kidney tissue. I think it is perfectly possible from the way that the upper part of this kidney lay over the brim of the pelvis that it might be torn away from the lower part by the pressure of a large head as it went through the superior strait. I felt that the possibility of pregnancy and its attendant dangers was the indication for operation in this patient; that there would not be the same indication for operation if the same kidney condition presented itself in a male.

The condition found is interesting from the point of view of the development of the kidney. In this instance the ascent of the kidney from its normal position at an early period of intrauterine life did not take place. The diminishing blood supply from the lower vessels that are becoming atrophic, the larger and newer blood supply from the upper vessels are interesting from the de-

velopmental point of view. The kidney is said to go up from the pelvis to the loin in sort of a hand over hand manner; new blood vessels extend from above to pull it up while the vessels below atrophy and let go their hold. It is the persistence of some of these vessels that should have atrophied, that in certain instances brings about the interference with the kidney's ability to empty itself, which results in a hydronephrosis. The position of the kidney with the pelvis looking forward is normal in early intrauterine life and this kidney occupied such a place: on its way up to the loin the kidney rotates. I do not know whether or not the bowing forward of the ureter, seen in this instance, is a normal condition, providing a redundancy of ureter, so to speak, to allow the ascent of the kidney to the loin.

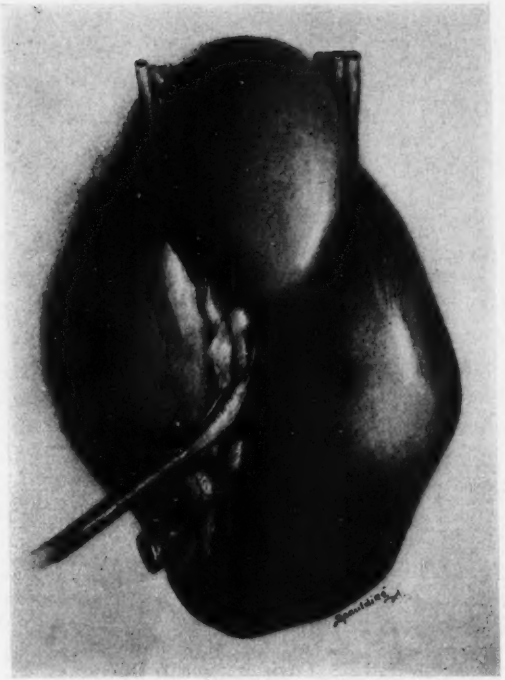


FIG. 1. PELVIC KIDNEY

Anterior view of kidney in position; the two sets of vessels above coming from the aorta; the ureter arises from the center of the cut; the lower vessel (which is drawn entirely too large) took its origin from the sacralis media.

FIG. 2. CASE OF SACRAL KIDNEY

Vessels coming from the aorta are seen above on either side; below on the left is seen the vessel which arose from the left internal iliac; on the right is seen diagrammatically the ureter; the kidney is seen from behind.

A CASE OF REDUPLICATION OF LEFT URETER AND LEFT RENAL PELVIS

R. F. O'NEIL

Massachusetts General Hospital, Boston, Massachusetts

Received for publication August 10, 1922

Since the wider application of the pyelogram and the ureterogram anomaly of the urinary tract are found to occur more frequently than was formerly supposed. Still they are of sufficient rarity to warrant putting on record such cases as the following. It is a well established fact that given an anomaly of the urinary tract, the abnormal organ is the one which is much more prone to be the site of any disturbance than is a normal organ, and when any abnormalities are found it is of interest to determine whether or not they are the cause of existing symptoms. The history of the case is as follows:

Mrs. X. Twenty-eight years of age, married. Referred by Dr. James L. Huntington of Boston, for diagnosis as to the cause of pain in the left loin and frequent micturition. The pain in the left loin began during her only pregnancy, four and one half years ago. During the last six weeks of pregnancy, the pain was severe, she also had frequency of micturition and was told that she had albumin in her urine at that time. There was a hard labor with a breech presentation. Her convalescence was normal and uneventful. At the present time she complains of a constant pain and ache in the left loin. This is not relieved by lying down and the pressure of her corset causes discomfort. There is urinary frequency of about once an hour during the day and nocturia for from five to seven times. There is some nausea just before menstruation when all symptoms are aggravated. Two months ago she had a bad fall on the ice striking the left side. Since then the pain has been very much worse.

Examination shows a thin woman. Abdomen, right rectus scar from appendix operation when she was thirteen years old. Both kid-

neys are palpable. The left more easily than the right. Neither is tender. Pelvic examination moderate prolapse of the uterus. Otherwise negative. Nothing found which would cause symptoms. On standing, the posture is faulty and there are definite signs of ptosis. There is also localized tenderness on the left side of the spine in the region of the second lumbar vertebra. In view of the urinary frequency and the pain in the loin, cystoscopic examination and pyelogram was advised. Catheter specimen of urine was clear, contained no albumin, no sugar and the sediment a few epithelial cells only. There may have been a pyelitis present during her pregnancy, but if so no trace remains at present.

Cystoscopy. The urethra was tight to the passage of an ordinary cystoscope. The bladder mucous membrane was normal. On the right was a normal appearing ureteric orifice. On the left, in the usual position was a normal appearing orifice. Immeditely posterior to this was a second orifice also normal in appearance. Both of these on the left were catheterized with no. 5 radiograph catheters. The catheter in the anterior opening passed apparently to the renal pelvis and drained clear, normal looking urine. The catheter in the second orifice could not be passed as far up the ureter as the other. This one also drained clear, normal looking urine, but less in amount than the other. The cystoscope was then withdrawn and reintroduced and the right side catheterized to the renal pelvis, from which a normal ureteric flow of clear urine was obtained. Examinations of the urines from the kidneys showed from the right, occasional blood cell, otherwise negative. From the left, first opening, red blood cells only. From the second, red blood cells only. Cultures were sterile from all specimens. Renal function, 1 cc. phenolsulphonephthalein intravenously. Appearance time, right side, seven minutes, 15 per cent excreted in fifteen minutes. From the left side, from the first ureteric orifice (anterior) appearance time, two minutes 35 per cent in fifteen minutes. From the second orifice (posterior) only a trace of color was excreted in fifteen minutes, the appearance time being nine minutes. Taken to x-ray room, sodium bromide solution, 25 per cent was injected. On the right 5 cc., on the left, in the first ureter, at first 3 cc. and later 8. In the second ureter, at first 2 cc. and then 4 more. The x-ray report is as follows: In the plates taken after the catheters were in position one catheter is visible on the right and two on the left. There is no evidence of shadows suggesting stone in any portion of the urinary tract. One of the catheters on the left side passes well up into the upper pole of the kidney. The tip of the

other is opposite the transverse process of the fourth lumbar vertebra. The kidney outlines are visible on both sides. The left is nearly double the size of the right. After injection of the opaque mixture

FIG. 1. REDUPLICATION OF LEFT URETER AND LEFT RENAL PELVIS

the outline of the right kidney pelvis is well shown. It appears to be normal in shape and size. The calyces are also distinctly normal in appearance. On the left, a small abnormal pelvis is visible in the

upper portion of the renal shadow. In the lower portion a slightly larger, but definitely abnormal pelvic shadow is seen. The course of the second ureter is not outlined.

Findings. Anatomical variation of the left kidney. The x-ray findings in this case conform to the rule in such anomalies that the normally situated ureteric orifice is the one of the upper pelvis of the kidney. There was no reaction following the cystoscopy or the pyelogram, and in a couple of days urinary frequency had greatly improved, the intervals during the day being lengthened to several hours and the nocturia diminished to once or twice. I attribute this improvement to the dilatation of the urethra by the cystoscope, as there was certainly no cause to be found in the bladder or the urine to account for it otherwise.

This patient presented, on examination, signs of a certain amount of ptosis and faulty posture, and while a definite anatomical abnormality of the left kidney was found, there was no evidence that there was any renal obstruction, infection or dimunition of function other than one segment of the kidney was more active than the other. In view of this it seemed wise to have an orthopedic consultation, with the idea of a proper support for the abdominal organs and a correction of the posture to see if the symptoms could be relieved in this manner before suggesting any surgical procedure for the fastening up of the kidney. Although I have no doubt that the heavy organ on that side accounts to a considerable degree for her long standing pain and which may have become more prolapsed following the fall on the ice two months ago.

She was seen by Dr. R. B. Osgood at my suggestion, who makes the following report:

I find no evidence of bone or joint lesions, but very definite signs of ptosis and faulty posture, and a definite and sharply localized tenderness over the transverse process of the second lumbar vertebra. There seems to me also to be a little thickening in this region Although the x-ray is negative to any bone lesion, I feel that in her injury she bruised, and perhaps tore off some of the muscle attachments to this transverse process, to which she has never given any real protection. I shall hope by correcting her posture, giving her

support which will not press upon this region, but protect it from muscle strain, the condition could be gradually relieved.

Such a support was made for this patient, and although she has only been wearing it a short time, there is practically complete relief from pain, which, however, recurs at times when the support is removed. The day frequency of micturition having entirely disappeared and nocturia has been reduced to once. This improvement, as I said, I attribute to the full dilatation of the urethra, as it occurred before any supporting apparatus was worn. It seemed to me as if the pain in this case was largely caused by the ptosis of the heavy, enlarged left kidney, aggravated by the injury. Whether or not surgery is to be advised will have to be determined by the permanency of the relief afforded by the correction of the general ptosis and the improvement of the general condition.

DISCUSSION

Dr. A. H. Crosbie, Boston: I had the good fortune of being with Dr. Chute at the time he was studying and operating on this pelvic kidney. It is the only one I have seen up to the day I started for Atlantic City. I was then examining a boy, eight years old, who complained of frequency, whose urine was clear and crystalline, who had no albumin, but the sediment showed red blood cells and leucocytes. On cystoscopic examination the catheter passed up the ureter into the left side, and I then passed the catheter into the right ureter and it passed only a short distance. A radiogram taken then showed a shadow in the midline, the shadow resembling that of a stone. I then injected with sodium bromide, and the injection showed the blunted outlines of the calyces. I think there is no question it is a case of pelvic kidney.

In regard to Dr. O'Neil's paper—not infrequently in doing pyelograms we run across reduplications of the ureter, many times in normal and sometimes in diseased kidneys. I just picked up one here of a ureter which divides just below the kidney pelvis, and the kidney is perfectly normal. The kidney on the other side was hydronephrotic but single. Another case was one in a young woman where there was a great deal of destruction of the lower pole of the kidney. The upper pole was not so badly diseased. Dr. Chute suggested after I removed it that it was a case that might have been resected, but the girl was in rather poor shape, and it seemed wise to me at the time to do a nephrectomy as she had a functionally good kidney on the other side. That was a year ago, and she reported to me the other day as being well. The injection of the kidney after it was removed showed there was no connection between the two pelves. That ureter divided a few centimeters below the kidney. Then rather recently I had a woman in whom I catheterized the right ureter with ease, and when I went to catheterize the left, there was a

large cystic dilatation as large as a hen's egg; and it was impossible to see any ureteral opening and I could not get a catheter up in any way. Under spinal anesthesia I opened the bladder and above this dilatation was a little fold into which I could introduce a ureteral catheter which passed some distance. I then opened the cystic dilatation. There was a gush of turbid fluid from it. I then put my finger up and found there was an opening which looked as if it might be another ureter. I passed a catheter up this and then we had radiograms taken which showed a double kidney with considerable destruction of the calyces. There was so much destruction in that that it seemed best to remove it which I did. I found the ureter which had gone to the cystic dilatation very much dilated. Both ureters were dilated but that very much more than the one on the other side; and the picture shows that and the fact that there is no connection between them.

Dr. WILLIAM C. QUINBY, Boston: It may be of interest in the report which Dr. Chute has made and the fear that he has expressed that a pelvic kidney might interfere with delivery, to report an analogous case in which pregnancy had occurred. Following her delivery, although she had never had such symptoms before, the patient experienced severe recurrent attacks of abdominal cramps, and on investigation these were found to be due to urinary retention in a pelvic kidney exactly of the type which Dr. Chute has described. Apparently the kidney had become dislocated in its precarious position and had become partially obstructed, as a result of the pregnancy and labor, though it had not offered any mechanical obstruction of itself at the time of delivery.

Dr. E. L. KEYES, JR., New York: I was able a few weeks ago to save a displaced kidney of much this general type which was over the fifth lumbar vertebra and the arteries of which all came from the aorta. The woman, a middle aged person, came to me complaining of symptoms of nephroptosis. She had no appreciable hydronephrosis and the condition was diagnosed by pyelo-

gram. I did a mid rectus incision and finding the kidney somewhat movable, moved it up as high as I conveniently could, about 6 cm., without disturbing its blood supply; and fixed it by flaps of the peritoneum sutured to the psoas muscle, one flap on each side of the ureter. She was relieved of all of her symptoms of ptosis up to the time she left the hospital. She walked around the hospital for four or five days before leaving. Then on getting home the pain recurred as a result of pull on the psoas muscle. This is now getting better, and she bids fair to be cured. Dr. Dougal Bissel has reported 3 cases cured in this manner.

Dr. A. J. CROWELL, Charlotte, N. C.: I think these abnormalities of the kidney are more frequently found than are usually supposed. During the last twelve or fifteen months we have seen 3 cases with double ureter and double kidney pelvis and one with a single ureter and a double kidney pelvis. Two of these cases were quite important to us in carrying out treatment. One had a double ureter and double pelvis on the left, and a nephroptosis with marked infection and a fairly large pelvic stone in the right kidney. All three ureters were catheterized and found that the secretion of the kidney was perfectly good and that on the right was rather poor and accompanied with considerable infection. We decided, because of the marked infection, impairment of the kidney function and nephroptosis to remove the right kidney instead of doing a pyelolithotomy on that side.

The second case was of importance to us because there were 10 ureteral stones in the lower end of one of these ureters, one of which was quite large. Having 2 ureters on that side, it was very necessary to know in which one of these the stones were located. Investigation showed that they were all in one ureter. These were removed by ureteral anesthesia and ureteral dilatation. The largest stone in this number was the largest we have ever removed from the ureter by any method. These abnormalities found in our practice have caused us to be on our guard and to constantly look for them. There was infection in the lower pelvis on the right side,—the one in which the stones were

lodged,—and its function considerably impaired. Their removal was followed with pelvic lavage until the infection disappeared. We feel the latter is an important procedure in order to prevent recurrence.

Dr. CHUTE: I have nothing to add.

Dr. O'NEIL: I have nothing to add.